NUCLEAR SCIENCE ABSTRACTS

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Abstracts 15470-18333

April 30, 1971

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Volume 25, Number 8, April 30, 1971

NUCLEAR SCIENCE ABSTRACTS

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

ISHIHARA, T., Accumulation of fallout ^{137}Cs in newborn infants, 23:50538
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Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

MELPHALAN
  effects on proliferation of cultured antigen-stimulated spleen cells from mice, dose-response curve for, 23:50820
MEMBRANE FILTERS
  design for removal of cell-free Streptococcus faecalus from bacteria cultures in fermentation tank, 23:49996 (UCRL-18667, pp 322-9)
MENDELEVIUM
  separation from einsteinium and fermium by electrolysis, 23:49772 (UCRL-18667, pp 277-312)
  separation from sodium acetate solutions by solvent extraction using sodium amalgam, 23:49772 (UCRL-18667, pp 277-312)
  stability of divalent state of, 23:49772 (UCRL-18667, pp 277-312)

Corporate Authors

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51093 (LA-4164) FABRICATION OF BORON CARBIDE RINGS AND DISKS. Sheinberg, H.; Herrera, T.; Kostacopoulos, J. **(Los Alamos Scientific Lab., N. Mex.).** Apr. 25, 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 15562 and 15753.

15470 ANALYTICAL CHEMISTRY OF TECHNETIUM, PROMETHIUM, ASTATINE, AND FRANCIUM. Lavrukhina, A. K.; Pozdnyakov, A. A. Analytical Chemistry of the Elements. Ann Arbor, Mich.; Ann Arbor-Humphrey Science Publishers (1970). 316p.

Translation of Analiticheskaya Khimiya Tekhnetsiya, Prometiya, Astatina i Frantsiya by R. Kondor.

General information on the properties of the four elements and their compounds is given followed by a discussion of the chemical reactions that are the basis of the analytical work. The physical, physicochemical, and chemical methods for the quantitative determination of the element are given in the following order: the analysis of raw materials; the analysis of the typical semimanufactured products; and the analysis of the finished products, such as metals or alloys, oxides, salts, and other compounds and materials. The underlying principles are always explained; and, whenever necessary, the exhaustive description of the entire analytical procedure is given. A separate discussion is allotted to techniques for the determination of inpurities in high-purity materials. Particular stress is placed on the accuracy and sensitivity of the various methods, in view of the general tendency toward increased sensitivity of determination of traces of impurity elements. Extensive bibliographies are given at the end of each of the four chapters. A subject index is appended. (P.C.H.)

Chemical and Spectral Procedures

Refer also to abstracts 15658, 15737, 15958, and 15977.

15471 (AEC-tr-7214, pp 220-6) RESULTS OF DETERMINATION OF ^{90}Sr IN WATERS OF THE INDIAN OCEAN IN 1962. Popov, N. I.; Orlov, V. M. Translation of A-AC-82/G/L-1177.

From USSR reports on radioactivity in man and the environment.

Water samples were collected by means of a bathometer with a volume of 200 l. The sampling horizon was determined from the length of the trawl cable and was monitored with respect to the chemical composition of the water by means of comparison with the results of hydrochemical series. Further processing of the water on board the ship was limited to precipitation of the carbonates of the alkaline earth elements. The precipitates obtained were analyzed for ^{90}Sr content at the fixed laboratory in accordance with a previously described methodology. The concentration and nature of the distribution of ^{90}Sr in the waters of the northeastern region of the Indian Ocean in the summer of 1962 in their general features were analogous to those that were observed in 1960 to 1961 in the central and northern regions of the ocean. It was observed that the reagents used for the determination of ^{90}Sr may carry a noticeable background activity. The establishment of dry-run analyses is a necessary condition for the correct estimation of the ^{90}Sr content in samples of ocean waters. (P.C.H.)

15472 (IN-1460) COMPUTER-ASSISTED DATA REDUCTION AND REPORT GENERATION FOR FLAME SPECTROMETRY. Baldwin, Jon M. (Idaho Nuclear Corp., Idaho Falls). Jan 1971. Contract AT(10-1)-1230. 64p. Dep. NTIS.

An approach to computerizing the data reduction and report preparation for routine flame spectrometric analyses is described. Some problems that were encountered in designing the general approach to the problem are discussed. The computer routines that were developed for the IBM 360/75 are presented with detailed instructions for their use. Examples of the application of the programs are included. (auth)

15473 (MLM-1777) DETERMINATION OF WATER IN 2-ETHYL-1-HEXANOL. Woltermann, H. A.; Ulrick, T. L.; Jarvis, J. Y. (Mound Lab., Miamisburg, Ohio). 12 Feb 1971. Contract AT(33-1)-Gen-53. 8p. Dep. NTIS.

In the sol-gel process for producing $^{238}PuO_2$ microspheres, the dehydration rate of the microspheres in the sphere-forming column is critical. Therefore, for adequate process control, it is necessary to monitor the water in the column solvent, 2-ethyl-1-hexanol. Two methods are described for the determination of water in this solvent; one, by gas chromatography utilizing a Porapak Q column at 100°C; and the other, by measuring the water absorption peak at 1925 mμm. (auth)

15474 (Y-1757) TIME-RESOLVED SPARK-SOURCE MASS SPECTROMETRY: THE EFFECT OF SPARK DURATION ON RELATIVE SENSITIVITY FACTORS, ION INTENSITY, AND PRECISION OF ANALYSIS. Franklin, J. C. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 29 Jan 1971. Contract W-7405-eng-26. 121p. Dep. NTIS.

Thesis.

A radio-frequency, high-voltage spark ion source in conjunction with a double-focusing mass spectrometer was used to measure the relative sensitivity factors for several elements in matrices of tin, iron, beryllium oxide, uranium, and steels. The sensitivity factors were examined for concentration and matrix effects. No significant variations were found for the concentration ranges studied, but there were very large sensitivity variations with changes in the matrix type. The precision in determining concentrations and relative sensitivity factors was compared for two methods of data interpretation and, in one case, a decrease in precision was shown to be due to sample nonhomogeneity. Because of the lack of reproducibility in the relative sensitivity factors and the corresponding lack of accuracy, a study was made of ion-intensity variations with elapsed time in a radio-frequency spark pulse. Circuits were designed and installed to synchronize the ion-beam chopping circuits with the radiofrequency spark pulses so that time-resolved spectra were obtained at different periods in the spark pulse. Large variations in the intensity of individual ion intensities were observed. In addition, the multiply charged species exhibited a behavior very different from the singly charged ions. Relatively stable periods of ionization were observed in the interior of the spark pulse. Therefore, data were collected from the interior of the pulse using standard iron as the analytical sample. The analysis using the time-resolved beam pulse from the spark had significantly better precision than analytical results taken without the pulse. In fact, the precision improved from +11.1, −9.9 percent to +5.5, −5.2 percent, which was very near the limiting precision of the photographic emulsion. (J.G.B.)

15475 POLAROGRAPHIC DETERMINATION OF TUNGSTEN. Eristavi, D. I.; Eristavi, V. D.; Daneliya, A. G. (Polytechnical Inst., Tbilisi, USSR). Zh. Anal. Khim.; 26: 183-4(Jan 1971). (In Russian).

For the polarographic determination of tungsten in solutions containing vanadium, these elements are separated by means of an

AB-17 anion exchanger in the carbonate form. The determination of microamounts of tungsten with a maximum relative error of ±8% is possible. The method has been used for the analysis of tungsten and vanadium alloys. (auth)

15476 EFFECT OF SOLUTION COMPOSITION ON SPECTROGRAPHIC DETERMINATION OF THE RARE EARTHS. Karpenko, L. I.; Fadeeva, L. A. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 26: 80-5(Jan 1971). (In Russian).

The effects of the elements of Groups I and II and also other groups of the periodic system on the excitation of the rare earth spectra in a spark discharge depend on the concentration and ionization potential of the "third" component. The change of the nature and concentration of certain mineral and organic acid anions (Cl^-, NO_3^-, SO_4^{2-}, BO_3^{3-}, EDTA, CH_3COO^-) does not appreciably affect the value of the relative intensity lines of the rare earth lines. Conditions have been found under which the change of the sample composition does not affect the results in the determination of rare earths. (auth)

15477 EMISSION SPECTROMETRIC DETERMINATION OF THE NITROGEN ISOTOPE RATIO. Kirkpatrick, James Willis. Urbana, Ill.; Univ. of Illinois (1970). 94p. University Microfilms Order No. 70-20,997.

Thesis.

An investigation of the optical emission method for the determination of the ratio $^{15}N/^{14}N$ was made and a reliable and relatively simple system was developed for its determination. A unique sampling and excitation system and two types of measurement and readout systems were developed to increase the precision and speed of the $^{15}N/^{14}N$ quantitative method. A microwave excitation source was constructed and its characteristic parameters relative to the $^{15}N/^{14}N$ determination were studied. A commercially available scanning monochromator that is modified to scan repetitively across the $^{15}N/^{14}N$ line pair selected for the determination of the isotope ratio was used in this work. This is easily accomplished with the addition of a simple latching relay circuit with no modification of the basic monochromator unit. This modification permits easy multiple measurement of any one sample thus increasing the precision with which the isotope ratio can be measured. A direct reader using the same monochromator was also developed. This requires modification of the optical system wherein radiation at the entrance slit is sequentially divided into three segments by a rotary chopper and the isolated radiation collected at three offset exit slits. This method provides the advantages of a digital readout that is directly proportional to the isotope ratio, greater speed of determination of the ratio, and an output that is directly applicable for computer interfacing. A flow system for the introduction of N_2 into the microwave cavity was developed. The flow system overcomes the problems of "memory effect" (due to N_2 being driven into the walls of the discharge tube) and contamination of a sample by previous samples, which are encountered when a static sample is used. The flow system offers the advantages of direct preparation of the N_2 for immediate analysis at optimum pressure for excitation, fast and efficient flushing of N_2 from the system, and the use of only a mechanical pump because pumpdown to low pressures (below 10^{-3} torr) to clear the system is unnecessary. This system allows a complete determination of the isotope ratio to be made in 10 min, including the time necessary to obtain N_2 from an ammonium salt, scan over the line pair 5 to 10 times and obtain an average readout value for the N_2 ratio. The natural isotopic ratio (0.367%) using tank N_2 has been determined with a relative standard deviation of 2.5% using the flow system with the automatic scanning monochromator. The experimental parameters such as pressure, leaking versus carrier flow of the N_2, background subtraction, and effect of varying the VSWR (voltage standing wave ratio) have been investigated during the course of this work. (Diss. Abstr. Int., B)

15478 USE OF NEGATIVE SURFACE IONIZATION FOR ISOTOPIC ANALYSIS OR DETECTION OF ELEMENTS WITH A HIGH ELECTRON AFFINITY. Blais, Jean-Claude; Brunot, Alain; Cottin, Maurice; Ducroquet, Marie-Helene; Gitton, Bernard; Martiens, Christian (Univ., Paris). Compt. Rend.; Ser. C; 271: 1347-50(30 Nov 1970). (In French).

The formation of negative ions by the ionization of high electron affinity elements on a surface with a low work function was used as a method of ionization for isotopic analyses, or for the detection of elements using mass spectrometry. (France)

15479 LEAD IODATE AS REAGENT FOR MULTIPLICATION OF EDTA. INDIRECT DETERMINATION OF Bi, Fe, In, Th, Hg, Cu, Ni, Pb, Zn, Cd, Co, AND Al. Fritsche, U.; Weisz, H. (Univ., Freiburg i. B.). Mikrochim. Acta; No. 5, 1045-9(1970). (In German).

EDTA reacts with excess lead iodate quantitatively yielding lead–EDTA, whereby an equivalent quantity of iodate is set free. After filtration, acidification and addition of potassium iodide, there results the twelve-time amount of iodine, which is titrated with sodium thiosulfate. Bi, Fe, In, Th, Hg, Cu, Ni, Pb, Zn, Cd, Co, Al, are determined indirectly, in that a known excess of EDTA and a sufficient quantity of lead iodate are added. The portion of EDTA that is not consumed in the complexing of the cation to be determined sets free an equivalent amount of iodate, which can be determined iodometrically. The influence of a number of anions was investigated. (auth)

15480 POLAROGRAPHIC STUDIES ON URANIUM(VI) COMPOUNDS. I. SQUARE-WAVE-POLAROGRAPHIC DETERMINATION OF MICROAMOUNTS OF URANIUM. Guertler, O.; Chu-Xuan-Anh (Karl-Marx-Univ., Leipzig). Mikrochim. Acta; No. 5, 941-9(1970). (In German).

The reduction of uranium(VI) in sulfuric acid solutions was studied polarographically at the dropping mercury electrode and a square wave polarographic method for the determination up to 7×10^{-7} M uranium in the presence of 20 other metals is described. (auth)

15481 SEPARATION AND DETERMINATION OF TANTALUM AS TANTALUM PHOSPHATE. Marsh, Richard H. Detroit, Mich.; Wayne State Univ. (1967). 63p. University Microfilms Order No. 70-18,117.

Thesis.

Studies using pure Ta compounds demonstrated that tantalum phosphate may be precipitated quantitatively. The precipitate is stoichiometric in composition, is stable for weighing, and has a more favorable gravimetric factor than tantalum oxide. Separations from a variety of elements were studied, which indicated that Ti and W were partially coprecipitated. The determination of Ta in Carboloy gave high results because of coprecipitation of Ti and W. A method for the separation of ^{95}Zn and its daughter, ^{95}Nb, is proposed. This is accomplished by holding the Nb in solution with hydrogen peroxide while precipitating the Zn as its phosphate. The decontamination factor for Zn is 170 and for Nb is 85. (Diss. Abstr. Int., B)

15482 FLAME EMISSION SPECTROMETRIC DETERMINATION OF ALUMINUM, COBALT, CHROMIUM, COPPER, MANGANESE, NIOBIUM, AND VANADIUM IN LOW AND HIGH ALLOY STEELS. Fassel, Velmer A.; Slack, Robert W.; Kniseley, Richard N. (Ames Lab., Iowa). Anal. Chem.; 43: 186-91(Feb 1971).

The flame emission spectrometric determination of Al, Co, Cr, Cu, Mn, Ni, and V in low and high alloy steels is presented. No prior chemical separations are required. A nitrous oxide–acetylene flame, formed on a commercial slot burner normally employed for atomic absorption spectrometry, is used to excite the atomic spectra. The spectra are dispersed by a 0.5-meter, table-model spectrometer, and intensities are measured with a digital integrator. NBS certified low and high alloy standard samples were employed for calibration purposes. "Chemical" or "physical" interference effects were not evident since congruent analytical curves were obtained for a wide range of steel compositions. Coefficients of variation for quantitative determinations were equivalent or superior to those published for atomic absorption measurements. (auth)

15483 DETERMINATION OF TRACE QUANTITIES OF ALUMINUM AND CHROMIUM IN URANIUM BY GAS PHASE CHROMATOGRAPHY. Gentry, Claude; Houin, Colette; Malherbe, Pierre; Schott, Roger (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). Anal. Chem.; 43: 235-40(Feb 1971).

The method described here combines the techniques of solvent extraction and gas phase chromatography, and enables the limit of determination of aluminum and chromium in uranium to be reduced to 0.1 ppM. Aluminum and chromium present in uranyl nitrate solutions are extracted with benzene as the trifluoroacetylacetonates; the chromatographic analysis is carried out with an electron capture detector. The calibration curve is plotted for quantities of metal smaller than 10^{-4} μg. The method proposed is compared with a conventional method for concentrations of more than 5 ppM, and for lower concentrations, it is shown that the method remains valid by adding known amounts of metal to purified uranium. The effect of extraneous elements is studied and the possibilities for extending the method are discussed. (auth)

15484 DETERMINATION OF ALUMINUM BY THERMOMETRIC TITRATION. Everson, W. L. (Shell Development Co., Emeryville, Calif.). Anal. Chem.; 43: 201-5(Feb 1971).

Aluminum is conveniently determined by direct thermometric titration with potassium fluoride in sodium chloride–sodium acetate solution at pH 3.9. The chief advantage of the procedure

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is its selectivity; Ca is the only common metal which interferes at low concentrations and which cannot be masked. Be, Zr, and Th interfere seriously, but all other metals tested (including Ti, Fe, and the lanthanides) either do not interfere or can be masked at the 40-mg level or higher. The tolerance for calcium is about 8 mg. In a 40-ml titration volume, the usable range is 5 to 40 mg of Al and the optimum range is 15 to 30 mg. Repeatability and accuracy in the optimum range are within 0.5%. (auth)

15485 DETERMINATION OF PERCENT BURN-UP OF THE NUCLEAR FUEL ON THE BASIS OF THE MEASURING OF THE STABLE ISOTOPES OF NEODYMIUM. Krtil, Josef (Inst. of Nuclear Research, Rez, Czech.); Bulovic, V.; Maximovic, Z. Jad. Energ.; 17: 10-15(1971).

The determination of burnup in two specimens of nuclear fuels by measuring ^{148}Nd is described. ^{142}Nd was used as a spike. After suitable chemical separation the ratios of the tracer to the fission products of Nd were measured, and then used for the calculation of burnup values. The results obtained by this method were compared with those obtained by radiochemical procedures. The results of both methods are in good agreement. (auth)

15486 COMPARISON OF ANALYSES OF HIGH-PERCENTAGE HEAVY WATER SAMPLES BY DENSITY MEASUREMENTS AND BY INFRARED SPECTROSCOPY. Moravec, J.; Sara, V.; Vagner, J.; Kysela, J. (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ.; 17: 28-30(1971). (In Czech).

The infrared spectroscopy and pycnometer methods of D_2O determination in high-percentage samples are evaluated. A number of samples were analyzed, using the Perkin-Elmer 225 and UR 10 Zeiss-Jena spectrophotometers and infrared spectra measurements have been compared. The spectrophotometric analysis is described in detail. In practice, the two methods are of the same sensitivity and accuracy. The spectroscopic determination is more convenient for analyses in series. For determinations using the UR 10 spectrophotometer, the intensity scale must be calibrated. (auth)

15487 MICRODETERMINATION OF GOLD(III), SILVER(I), AND RUTHENIUM(III) BY RING COLORIMETRY AFTER SEPARATION BY THIN-LAYER CHROMATOGRAPHY (TLC). Johri, K. N.; Mehra, Harish C. (Univ. of Delhi). Mikrochim. Acta; No. 5, 807-10(1970).

Clean and speedy analytical separation of μg-quantities of Au(III), Ru(III), and Ag(I) from their mixed solution is accomplished by ascending thin-layer chromatography. For the evaluation of these metal ions, the spots are scooped out with the help of a Mottier gadget and the collected material transferred to the paper set on the ring oven. Separate rings were obtained for individual metal ions and the determination is carried out by ring colorimetry, using PTC as a fixing and complexing agent for washing to the ring. (auth)

15488 DETERMINATION OF TELLURIUM IN MICROGRAM AMOUNTS WITH THE HELP OF SIMULTANEOUS COMPARISON METHOD. Bognar, Janos; Jellinek, Olga; Sarosi, Szilvia (Technische Univ., Miskolc, Hungary). Mikrochim. Acta; No. 5, 811-19(1970). (In German).

A procedure was worked out for the determination of traces of tellurium with the aid of the simultaneous comparison method, and based on the bichromate-ferriin reaction. Ferriin is reduced by tellurium(IV); this process is induced by bichromate. In this procedure the traces of tellurium are precipitated by means of sodium hypophosphite reduction with arsenic or selenium as carriers. The metal precipitate is oxidized to tellurium(IV) with nitric acid; the samples under investigation and the standard series are started at the same time and compared. By means of this method it is possible to determine tellurium, even in microgram amounts, with an error of less than ±10%. Only the platinum metals and gold(III) interfere. (auth)

15489 DETERMINATION OF CARBON TRACES IN REFRACTORY METALS. Lassner, Erik (Metallwerk Plansee AG, Reutte/Tyrol, Austria). Mikrochim. Acta; No. 5, 820-30(1970). (In German).

Different sources of error in the determination of carbon within the range of 1 to 100 ppM in refractory metals such as niobium, tantalum, molybdenum, and tungsten and means of their elimination are discussed. Special attention must be given to sample preparation to exclude surface contamination. The exact combustion conditions for the oxidation in the tube furnace are described. A method for calibration by means of organic compounds, carbonates, and carbides which ensures exact determination at absolute carbon contents of 1 to 100 micrograms, is proposed. Plastic containers or bags are unsuitable for the storage and transport of powder samples because they lose low molecular carbon compounds which are adsorbed by the powder and thus give higher carbon contents. Finally, statistical data for the different methods are presented. At a variation coefficient of 5 to 10% at the aforementioned carbon contents, the reproducibility is excellent. (auth)

15490 CATALYMETRIC DETERMINATION OF IRIDIUM, OSMIUM, AND RUTHENIUM WITH THE HELP OF THE Ce(IV)-As(III)-FERROIN-Cl^- SYSTEM. Gillet, A. C. Jr. (Centre de Recherche de NOH, Brussels). Mikrochim. Acta; No. 5, 855-63(1970). (In French).

Iridium, osmium and ruthenium are determined by the catalymetric method previously proposed by Sandell and Kolthoff for iodide. The effects of some parameters on the catalysed Ce(IV) - As(III) reaction are reported and a reliable procedure is described for each element, with the following sensitivities: iridium: 0.002 mg/l, osmium: 0.2 mg/l, ruthenium: 0.005 mg/l. (auth)

15491 LIQUID-STATE, IODIDE-SELECTIVE ELECTRODE. Ruzicka, J. (Tech. Univ. of Denmark, Lyngby); Rald, K. Anal. Chim. Acta; 53: 1-12(Jan 1971).

The ion-sensitive surface of the liquid state electrode is formed by a very thin layer of an organic liquid, adsorbed at the surface of porous graphite. The composition of this organic phase, which must be immiscible with water, can be chosen so that the electrode responds only to the activity of a certain ion in the measured aqueous sample. The performance and construction of a liquid state electrode with solutions of iodine in carbon tetrachloride, benzene, and mesitylene as the organic phase are described. The electrode is suitable for measurement of iodide activities down to 10^{-6} M; it has selectivity ratios for iodide over bromide of about 10^{-3} and over chloride ion of better than 10^{-4}. In contrast to the solid state iodide-selective electrode (AgI/Ag_2S membrane), the liquid state electrode is not sensitive to light at any level of the iodide activities studied, but it is sensitive to species that would reduce iodine to iodide. (auth)

15492 PRECONCENTRATION OF VARIOUS TRACE ELEMENTS IN SEAWATER BY SOLVENT EXTRACTION AND THE RING OVEN. Armitage, Bruce; Zeitlin, Harry (Univ. of Hawaii, Honolulu). Anal. Chim. Acta; 53: 47-53(Jan 1971).

A procedure is described for the preconcentration from seawater without pretreatment of six trace elements, uranium, copper, nickel, cobalt, iron, and manganese, through solvent extraction with an 8-hydroxyquinoline-chloroform mixture. Extracted samples are deposited on filter paper disks with the aid of a kinetic clamp pump and a ring oven, and the six elements are determined nondestructively by x-ray fluorescence. Evaluation of the procedure with distilled water and seawater samples spiked with the metal ions, shows that extraction of the trace metals is essentially quantitative. (auth)

15493 DETERMINATION OF RUTHENIUM BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Montford, B.; Cribbs, S. C. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Anal. Chim. Acta; 53: 101-8(Jan 1971).

The effects of some 40 ions and various acids on the atomic absorption spectrophotometry of ruthenium solutions were studied. All produced interference; this was eliminated by the addition of uranium (4% (w/v)), or, in the case of titanium, by distillation of ruthenium tetroxide from oxidizing acid media. Lanthanum(III), strontium(II), hydroxylamine hydrochloride, perchloric acid, sodium sulfite, and sodium nitrate proved ineffective as interference suppressors. Uranium(VI) also enhanced the absorbance of ruthenium; the sensitivity for ruthenium (expressed as $\mu g\ ml^{-1}$ for 1% absorbance) was found to be 0.88 in the presence of uranium, and 1.0 after distillation. Recoveries of ruthenium by distillation were 98 ± 1.5%. (auth)

15494 DETERMINATION OF IODINE IN THE p.p.m. RANGE IN ROCKS. Grimaldi, F. S.; Schnepfe, M. M. (Geological Survey, Washington, D. C.). Anal. Chim. Acta; 53: 181-4(Jan 1971).

The procedure given for determining iodine in geological materials involves sample preparation and the conversion of iodide and iodate to iodine, which is extracted into carbon tetrachloride and determined spectrophotometrically. Approximately 1 ppM can be determined as a lower limit on a 1g sample. (D.P.O.)

15495 USE OF LENS MASKS TO IMPROVE SENSITIVITY IN ATOMIC ABSORPTION SPECTROPHOTOMETRY. Hildon, M. A.; Sully, G. R. (Roan Selection Trust Tech. Services, Kalulushi, Zambia). Anal. Chim. Acta; 53: 192-4(Jan 1971).

A simple arrangement of lens masks gave some improvement in sensitivity for the atomic absorption spectrophotometric determination of every element and in every flame investigated. (D.P.O.)

15496 RAPID SPECTROPHOTOMETRIC METHOD FOR FREE ACID DETERMINATION IN URANYL NITRATE AND CHLORIDE SOLUTIONS. Bhargava, V. K.; Chandrasekharan, E. S.; Rao, V. K.; (and others) (Bhabha Atomic Research Centre, Trombay, India). Anal. Chim. Acta; 53: 210-13(Jan 1971).

A rapid spectrophotometric method was developed for the determination of free nitric and hydrochloric acids at three different wavelengths in solutions containing the uranyl ion. The method is applicable for the determination of free acid in the range 0.5 to 4.0 M. (D.P.O.)

15497 DETERMINATION OF STRONTIUM BY ATOMIC ABSORPTION SPECTROPHOTOMETRY IN A NITROUS OXIDE–ACETYLENE FLAME. Musha, Soichiro (Osaka Univ.); Munemori, Makoto; Hosogaki, Ryuichi. Jap. Anal.; 19: 1618-24 (Dec 1970). (In Japanese).

In a nitrous oxide–acetylene flame, strontium is partially ionized to give a calibration curve that bends toward the absorbance axis. The apparent ionization degree was determined to be 82% for 2 ppM of strontium by measuring the absorbance at 4607 Å atom resonance line and 4077 Å ion resonance line. In the presence of a large amount of potassium chloride, the ionization of strontium is suppressed and a straight calibration curve was obtained for 0.2 to 1.0 ppM of strontium. Coexistent elements having an ionization potential value smaller than about 6.8 eV enhanced the strontium absorption, but this enhancement apparently disappeared on addition of potassium chloride. The above-mentioned enhancement could be explained in terms of the suppression of the ionization of strontium. Almost all elements except silicon and mineral acids gave no interference when the absorption measurement was carried out with added potassium chloride. Strontium in Portland cement, cathode oxide for vacuum tubes, animal bone, and milk powder was determined by measuring the absorbance at 4607 Å in the presence of 2000 ppM of potassium and the results were in good agreement with those obtained by other methods. (auth)

15498 ULTRAVIOLET SPECTROPHOTOMETRIC DETERMINATION OF TELLURIUM(IV) WITH PYRROLIDINECARBODITHIOIC ACID. Hayashi, Kenjiro (Yamaguchi Univ., Japan); Sasaki, Yoshiaki; Nakanishi, Michio; Ito, Saburo. Jap. Anal.; 19: 1673-7 (Dec 1970). (In Japanese).

Pyrrolidinecarbodithioic acid (PDTC) forms a sparingly soluble precipitate with tetravalent tellurium. This precipitate dissolves in methyl isobutyl ketone (MIBK) and other organic solvents. The complex in organic solvent is unstable, and fading occurs rapidly. However, tellurium(IV) reacts with PDTC to form a yellow water-soluble complex in the presence of surface active agents such as Triton X-100 (alkylaryl polyether alcohol). It is assumed that the solubilization of the complex is caused by the resolution of it into micelles formed in water, because the sparingly soluble precipitate dissolves easily in pure Triton X-100 and its solution gives a similar coloration. The water-soluble complex was stable and Beer's law held for 5 to 70 μg of tellurium in 20 ml of the aqueous solution containing 1 ml of 0.83% Triton X-100 solution and 1 ml of 6.1×10^{-3} M PDTC solution at pH 1.0 or 4.7. The apparent molar extinction coefficients at 300 mμ and 310 mμ were 5.31×10^4 and 4.86×10^4, respectively. The interference from iron was removed by extracting iron as the cupferrate complex and that from nickel, zinc, cadmium, and copper was avoided by extracting tellurium with MIBK. (auth)

15499 RADIOISOTOPIC X-RAY ANALYSIS OF SILVER ORES USING COMPTON SCATTER FOR MATRIX COMPENSATION. Burkhalter, P. G. (Bureau of Mines, College Park, Md.). Anal. Chem.; 43: 10-17(Jan 1971).

Radioisotopic x-ray analysis with semiconductor detectors was evaluated for determining silver in ores. X-ray and scatter peak intensities were obtained using computer processing for curve fitting backgrounds under the Ag Kα peaks and unfolding overlapping spectra. The discrete Compton and coherent scatter peaks obtainable with monoenergetic excitation were evaluated as internal standards for matrix compensation. The Ag Kα-to-Compton ratio provides compensation for X-ray absorption and a single, linear calibration curve can be used for silver determination in both uniform and variable matrix ores. For a set of samples taken from a drill core, silver was determined to within ±10% for concentrations above 3 oz/ton and the detection limit was 0.3 oz/ton (10 ppM). For variable matrix ores, silver can be determined within ±20%. (auth)

15500 DETERMINATION OF NITROGEN IN VANADIUM NITRIDES AND URANIUM NITRIDE (UN). Bollman, Dean H.; Mortimore, D. M. (Bureau of Mines, Albany, Oreg.). Anal. Chem.; 43: 154-5(Jan 1971).

To obtain accurate and simplified methods for nitrogen determination in vanadium nitrides and uranium nitride, various procedures were attempted. A description of the Kjeldahl distillation and titration method used is given. (D.P.O.)

15501 DETERMINATION OF NITRITE BY CONTROLLED-POTENTIAL COULOMETRY. Harrar, J. E. (Univ. of California, Livermore). Anal. Chem.; 43: 143-5(Jan 1971).

A simple, accurate method for determination of nitrite by coulometry at controlled potential is described. Nitrite is oxidized directly to nitrate at a platinum electrode in pH 4.7 acetate buffer. Possible loss of nitrous acid is not a factor in the analysis. Forty-five species were tested and results summarized for their effect on the determination of nitrite. (D.P.O.)

15502 FLUOROMETRIC METHODS FOR DETERMINATION OF EUROPIUM AND TERBIUM. Williams, Dora E.; Guyon, John C. (Univ. of Missouri, Columbia). Anal. Chem.; 43: 139-40(Jan 1971).

1, 1, 1, 5, 5, 5-Hexafluoro-2, 4-pentanedione chelates of europium and terbium provide a method for the selective fluorometric determination of nanogram quantities. Data are given to show that Eu and Tb can be determined in the presence of foreign ions and other rare earth ions without a separation procedure. (D.P.O.)

15503 SPECTROPHOTOMETRIC DETERMINATIONS OF IRON(III), MOLYBDENUM(VI), AND VANADIUM(V) IN PRESENCE OF EACH OTHER AND OTHER IONS WITH 1-(2-CARBOXY-4-SULPHONATOPHENYL)-3-HYDROXY-3-PHENYLTRIAZENE AS REAGENT. Majumdar, A. K.; Chakraborti, D. (Jadavpur Univ., Calcutta). Anal. Chim. Acta; 53: 127-34(Jan 1971).

1-(2-Carboxy-4-sulfonatophenyl)-3-hydroxy-3-phenyltriazene is reported as an excellent spectrophotometric reagent for the determination of iron(III), molybdenum(VI), and vanadium(V). At pH values of 3.3 to 4.5, 3.0 to 4.2, and 3.0 to 6.5, iron(III), molybdenum(VI) and vanadium(V) form bluish violet, yellowish green and yellow complexes with maximum absorbances at 410, 405, and 405 nm, respectively. Beer's law is valid, with optimum ranges of 1 to 12 ppM for iron(III), 2 to 12 ppM for molybdenum(VI), and 1 to 6 ppM for vanadium(V); the percentage relative errors are 2.66, 2.68, and 2.74, respectively. Iron(III) and molybdenum(VI) form 1:2 complexes with the reagent, and vanadium(V) forms a 1:1 complex; the instability constants of the complexes are of the order 10^{-8}, 10^{-7}, and 10^{-4}, respectively. Effects of other anions and cations on the color systems are listed, and a procedure for the determination of iron, molybdenum, and vanadium in the presence of each other is described. (auth)

15504 DETERMINATION OF THE ISOTOPIC COMPOSITION OF ATMOSPHERIC HELIUM. Mamyrin, B. A.; Anufriev, G. S.; Kamenskii, I. L.; Tolstikhin, I. N. (All-Union Petroleum Geology Exploration Inst., Leningrad. Inst. of Precambrian Geology and Geochronology, Leningrad). Geochem. Int. (Engl. Transl.); 7: 498-505(Jan 1970).

Translated from Geokhimiya; No. 6, 721-30(1970).

A method is presented for measuring the ratio of the helium isotopes in air, which is based on comparing mass spectra for air helium with results on mixtures prepared by mixing ^3He with ^4He. A detailed analysis is presented for the possible sources of systematic error. The result for Leningrad air is $^3He/^4He = 1.399 \pm 0.013 \times 10^{-6}$. Preliminary results show that the ratio is constant at $1.40 \pm 0.03 \times 10^{-6}$ with latitude, longitude, and height (up to 10 km). (auth)

Isotope Dilution Procedures

Refer also to abstracts 15781, 15886, 15911, 15915, 15916, and 18248.

15505 (N-70-38452) DETERMINATION OF CERIUM, GADOLINIUM, DYSPROSIUM, ERBIUM, AND YTTERBIUM. Komori, Takuji. Translated from Jap. Anal.; 15: 589-93(1966). 16p. (NASA-TT-F-13177). NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 33203.

15506 MASS SPECTROMETRIC DETERMINATION OF METAL CHELATES. III. QUANTITATIVE DETERMINATION OF IRON AT THE PICOGRAM LEVEL USING THE ISOTOPE DILUTION METHOD. Terlouw, J. K.; de Ridder, J. J. (Univ., Utrecht). Z. Anal. Chem.; 252: 377-8(1970).

The determination of Fe using dibenzoylmethane as a ligand instead of acetylacetone is reported. An alternative procedure, which consists of the so-called integrated ion-current method, was used for the registration of peak intensities. However, a metal-labeled chelate was used as internal standard instead of an external reference compound. When an AEI MS 9 mass spec-

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trometer was used, determinations of Fe could be performed down to 5×10^{-12} g with an accuracy and reproducibility of better than 3%. Memory effects can be eliminated by introducing a microgram amount of aluminum dibenzoylmethanate. Consequently, the present determination turned out to be 10^3 times as sensitive as methods described previously. Limitations of the method are discussed. (P.C.H.)

15507 RADIOCHEMICAL DETERMINATION OF SMALL AMOUNTS OF TANTALUM WITH SUBSTOICHIOMETRIC SEPARATION. Bilimovich, G. N.; Alimarin, I. P.; Tikhonova, T. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 26: 122-5(Jan 1971). (In Russian).

A method has been developed for the substoichiometric separation of traces of tantalum by its extraction with a solution of triphenylguanidinium in nitrobenzene and determination by the methods of isotope dilution and radioactivation analysis. Down to 10^{-4}% of tantalum can be successfully determined with substoichiometric amounts of the reagent by the isotope dilution technique. At concentrations down to 10^{-8}% the method of radioactivation analysis is more suitable. (auth)

15508 USE OF SODIUM TETRAPHENYLBORATE FOR SUBSTOICHIOMETRIC ISOLATION OF CESIUM IN ANALYSIS BY THE ISOTOPE-DILUTION METHOD. Pomerantseva, A. V.; Atrashkevich, V. V.; Zimakov, I. E.; Spitsyn, V. I. (Inst. of Physical Chemistry, Moscow. Scientific-Research Inst. of Technical Glass, Moscow). Zh. Anal. Khim.; 26: 43-7(Jan 1971). (In Russian).

Extraction of Cs by nitrobenzene in the presence of substoichiometric ($\geq 10^{-6}$ M) amounts of sodium tetraphenylborate has been used for the substoichiometric isolation of cesium during its determination by the isotope dilution method. The use of sodium tetraphenylborate for determining cesium by means of the isotope dilution method permits the decrease of the determinable minimum down to 0.5 μg/ml of Cs as compared with the use of magnesium dipicrylaminate for the same purpose. A method has been developed for determining 0.5 to 5 μg/ml Cs in solutions with a mean error of ≤10%. (auth)

15509 ISOTOPE DILUTION DETERMINATION OF CHROMIUM AS DOUBLY LABELLED $^{110m}Ag_2{}^{51}CrO_4$. Gard, E. (Inst. of Atomic Physics, Bucharest). Mikrochim. Acta; No. 5, 983-7 (1970).

A chromium determination is presented as a model of the doubly labeled compound technique in isotope dilution determinations. The specific radioactivities (a_{Cr}, a_{Ag}) of the parent soluble compounds and the activities (A_{Cr}, A_{Ag}) obtained (as gamma-photopeak areas) from an amount w of isolated $^{110m}Ag_2{}^{51}CrO_4$ precipitate, are related by $(A_{Cr}/F_{Cr}a_{Cr}) = (A_{Ag}/F_{Ag}a_{Ag}) = w$, where F_{Cr} and F_{Ag} are stoichiometric conversion factors, which gives the isotope dilution equation as $(A_{Ag}/A_{Cr}) = k(a_{Ag}{}^0/a_{Cr}{}^0) + (a_{Ag}{}^0/a_{Cr}{}^0 \cdot m) \cdot x$, where the experimentally obtained A_{Ag}/A_{Cr} ratios correspond to the dilution with a known quantity m of chromium compound of an unknown amount x in solution. Statistical analysis of the results for several known x values gave m = 0.102 ± 0.003 and a standard straight line for unknown values of x. The technique is also valid for fission product activity determinations, irrespective of their chemical separation yield. (auth)

Radiometric and Radiochemical Procedures

15510 (AEC-tr-7196) BETA-BACKSCATTERING TECHNIQUE DETERMINATION OF SULFUR IN CERTAIN SULFUR ORE PROCESSING INTERMEDIATE PRODUCTS. Parus, J. Translated from Chem. Anal. (Warsaw); 13: 49-54(1968). 11p. Dep. NTIS.

Determinations of sulfur in certain intermediate products of ore processing are described. They were carried out under industrial conditions with the aid of a beta-back-scattering apparatus. The accuracy of the determinations in ore concentrates, filtration cakes, flotation machine feeds, classifier overflows, and raw ores is ±0.5% (absolute). The analysis takes 15 to 17 min in total. Calibration of the system and preparation of samples are described. (auth)

15511 (CEA-R-4020) TRITIUM DETERMINATION IN METALS BY COMBUSTION IN OXYGEN. Truffier, Jean-Louis; Corpechot, Philippe (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Dec 1970. 41p. (In French). Dep. NTIS (U. S. Sales Only).

A description is given of the method used experimentally for determining tritium contained in metals. The tritium is extracted in the form of tritiated water by burning the sample in a sealed quartz tube filled with oxygen and heated to a high temperature. A calibration method is proposed, and a description is given of the results obtained on samples of iron, copper, and magnesium. (auth) (France)

15512 (DP-1243) COMPARISON OF METHODS FOR ASSAYING ^{252}Cf. Overman, Robert F. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan 1971. Contract AT(07-2)-1. 16p. Dep. NTIS.

Three methods for assaying californium-252 are compared: neutron counting, alpha counting, and fission fragment counting. All three methods give consistent results; neutron counting is the most satisfactory method for routine use. Alpha counting requires correction for the counts contributed by fission fragments. (auth)

15513 (HASL-239, pp I.23-57) ANALYSES OF QUALITY CONTROL SAMPLES AT HASL AND A CONTRACTOR LABORATORY DURING 1970. Hardy, E. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

From Fallout Program quarterly summary report, September 1-December 1, 1970.

A summary of quality control data for bone ash, milk ash, vegetation ash, ion exchange resin, and simulated pot samples analyzed during 1970 is included. Results of individual analyses and average values are tabulated. Most of the materials analyzed, which includes calcium phosphate, milk ash, ion exchange resin, simulated pot collections, human and animal bones, vegetation ash, food ash, and tap water, were analyzed for ^{89}Sr, ^{90}Sr, and/or Ca. (P.C.H.)

15514 (HASL-239, pp I.58-62) QUALITY OF RADIOCHEMICAL ANALYSES IN THE HASL SURFACE AIR SAMPLING PROGRAM DURING 1969. Kleinman, Michael T.; Volchok, Herbert L. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

From Fallout Program quarterly summary report, September 1-December 1, 1970.

The results of radiochemical analyses of particulate matter in surface air for various radioactive components, such as ^{89}Sr, ^{90}Sr, ^{95}Zr, ^{137}Cs, ^{144}Ce, ^{238}Pu, ^{239}Pu, and stable lead are reported. The data are indicative of the accuracy of the radiochemical analyses. The analyses were performed on a monthly basis. (P.C.H.)

15515 MEASURING OF VERY LOW β-ACTIVITIES (FALLOUT) IN WATER AND ASHES AFTER ENRICHMENT BY SELECTIVE ION EXCHANGE. Hinzpeter, A. (Technische Univ., Hanover). Atompraxis; 16: 414-19(Nov-Dec 1970). (In German).

A simple method of ion exchange for the rapid enrichment of radioactivity (fallout) in water is described. By means of this method pure β-nuclides not detectable by γ-spectrometry, e.g., $^{90}Sr/^{90}Y$, can be measured. No chemical separation process is applied, but only the selective adsorption and desorption on ion exchange resin. In addition this method is well suited for the radiation analysis of ashes, especially with high calcium contents. The exchange efficiency for some important nuclides in a current of calcium ions was studied in detail. The technique has been in use in this laboratory for several years. The apparatus and experimental details are described. (auth)

15516 DETERMINATION OF SULPHUR AND ^{35}S IN MILK. Bates, T. H.; Boyd, T. H. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). Analyst; 95: 955-6(Nov 1970).

Sulphur compounds in milk are oxidised quantitatively to sulphate with Benedict's reagent. The sulphate is determined gravimetrically as barium sulphate, and the sulphur-35 content determined by radioassay of an aliquot of the barium sulphate as a gel in a scintillation medium. The presence of sodium hydroxide during the oxidation is essential for good recoveries. The validity of the method was confirmed by use of spikes of sulphur-35 labeled amino-acids. The limit of detection of the method is 50 pCi $litre^{-1}$. (auth) (UK)

15517 PROCEDURE FOR THE CHERENKOV COUNTING OF HIGH ENERGY β AND γ EMITTING RADIONUCLIDES IN COLOURED PLANT EXTRACTS. Ballance, P. E.; Johnson, Shirley (Univ. of East Anglia, Norwich, Eng.). Planta; 91: 364-8(1970).

Elimination of count rate variations caused by the absorption of Cherenkov radiation by pigments in colored solutions prepared from the roots and shoots of barley (Hordeum vulgare) was achieved by placing these solutions in opaque walled cylinders immersed in colorless liquids contained in standard counting vials used for scintillation counting. Good counting efficiencies for a range of β and γ emitting radionuclides (^{36}Cl, ^{42}K, ^{22}Na, ^{24}Na, and ^{32}P) were obtained by selecting colorless liquids with high refractive index. (auth)

15518 REVIEW OF ANALYTICAL METHODS FOR EXPLORATION GEOCHEMISTRY. Timms, A. B. (Australian Mineral Development Labs., Frewville). AMDEL (Aust. Miner. Develop. Lab.) Bull.; No. 9, 55-61(Apr 1970).

Factors common to all analytical methods are discussed, and analytical procedures and instrumentation currently in use in exploration geochemistry are reviewed. Reference is made to the use of emission, x-ray fluorescence, and atomic absorption spectroscopy as well as radiometric and spectrophotometric methods of analysis. (auth)

15519 DETERMINATION OF $^{234}U/^{238}U$ RATIOS IN SAMPLES OF NATURAL WATER. Szy, Denes; Toth, Arpad (Medizinische Semmelweis Univ., Budapest). Mikrochim. Acta; No. 5, 960-4 (1970). (In German).

A method suitable for the determination of the isotope ratio $^{234}U/^{238}U$ in natural waters is described. Conditions of the use of the most simple α-spectrometer, the scintillation spectrometer, are discussed. The principal steps of the procedure are given, and the isotope ratios of various water samples determined with the method described are presented. (auth)

15520 USE OF MICROMETHODS IN ORGANIC ISOTOPE GAS ANALYSIS. Mlinko, S.; Szarvas, T.; Gacs, I.; Payer, K. (Zentralforschungsinstitut fuer Chemie, Budapest. Institut fuer Isotopenforschung, Budapest). Mikrochim. Acta; No. 5, 900-4 (1970). (In German).

Atmospheric procedures are presented for the isotopic analysis of organic compounds labeled with ^{14}C, tritium or ^{35}S. These methods performed similarly to organize microanalyses may be used for radioactive measurements in the gas phase without applying a vacuum system. Radioactive measurements of organic compounds labeled with weak beta emitters may be carried out by atmospheric methods with microanalytical accuracy in a simple apparatus at a counter efficiency of 96 to 98%. (auth)

15521 MEASUREMENT OF RADIAL PROFILES OF FISSIONABLE MATERIALS AND FISSION PRODUCTS IN THE COATING LAYERS OF FUEL PARTICLES FOR HIGH-TEMPERATURE REACTORS. Bildstein, H.; Angelberger, P.; Muellner, P. (Reaktorzentrum, Seibersdorf, Austria). Mikrochim. Acta; No. 5, 905-13(1970). (In German).

A combination of recoil technique and chemical etching allows a determination of surface U/Th contamination and contamination profiles in coated fuel particles for HTGR. The release of fission products by diffusion through the coating is studied by evaluating their radial concentration profiles. (auth)

15522 OXYGEN FLASK ASSEMBLY FOR THE ASSAY OF ^{14}C IN BIOLOGICAL MATERIAL. Volf, V. (Institut fuer Strahlenbiologie, Karlsruhe, Ger.). Int. J. Appl. Radiat. Isotop.; 21: 685-6(Nov 1970).

An adaptation of the oxygen flask method is described, that employs rapid burning of specimens of biological material containing ^{14}C, by means of simple equipment. The combustion assembly is described in detail and the combustion of the sample and the absorption of gas are discussed. Recovery of ^{14}C activity was 98.7 ± 2.0 percent for dried samples of rat liver, kidney, intestine, and blood. (UK)

15523 DETERMINATION OF ^{226}Ra ACTIVITY IN NONEQUILIBRIUM STATE BY GAMMA SCINTILLATION SPECTROMETRY. Lenger, V.; Thomas, J. (Inst. of Radiation Hygiene, Prague). Nucl. Instrum. Methods; 91: 247-52(1971).

A new method for the determination of ^{226}Ra activity is described. It utilizes the direct evaluation of the 187-keV line from pure ^{226}Ra and the 1764-keV line from RaC. (auth)

15524 PREPARATION OF WHOLE BLOOD SAMPLES FOR ^{14}C COUNTING IN LIQUID SCINTILLATOR. Oustrin, J.; Rouquie, A. (CNRS, Toulouse). Int. J. Appl. Radiat. Isotop.; 21: 739-41(Dec 1970). (In French)

Dimethyl sulphoxide was used to denature haemoglobin in the hydrogen peroxide method of bleaching blood to improve the efficiency of liquid scintillation counting, and was found to give better results than either hydrogen peroxide alone or benzoyl peroxide in tests with rat blood and Bray's scintillator solution, an efficiency of over 50% being reached. (UK)

15525 ANALYSIS OF ORGANIC MATTER BY THE ELASTIC ALPHA PARTICLE SCATTERING METHOD. Habanec, J. (Inst. of Nuclear Research, Rez, Czech.); Plesek, J.; Hermanek, S. Jad. Energ.; 16: 367-8(Nov 1970). (In Czech).

The possibility of analyzing organic matter with the use of elastic scattering of alpha particles was verified. Particles with the energy of 25 MeV were utilized. The method was found to be very convenient for analytical purposes. The composition of the substance being analyzed was not changed during measurements. A method for the determination of the number of atoms in a compound is also described. (auth)

15526 RAPID RADIOMETRIC METHODS OF CHEMICAL ANALYSIS DEVELOPED IN THE INSTITUTE OF NUCLEAR TECHNIQUES OF THE ACADEMY OF MINING AND METALLURGY. Dziunikowski, Bohdan; Holynska, Barbara. Zesz. Nauk. Akad. Gorn.-Hutn. Krakow., Rozpr.; No. 208, 79-93(1969). (In Polish).

Physical principles of various radiometric methods of chemical analysis are outlined. Possibilities of applying the radiometric methods for industrial purposes are demonstrated. Examples of practical applications of these methods developed in the Institute of Nuclear Techniques for resolving different analytical problems are presented. Finally, the advantages and disadvantages of the radiometric techniques compared with classical methods of analysis are discussed. (auth)

15527 SELECTIVE NON-SPECTROMETRIC GAMMA-GAMMA METHOD OF DETERMINING THE Zn AND Pb CONTENT IN POLYMETALLIC ORES. Charbucinski, Jacek (Inst. of Nuclear Techniques, Krakow). Nukleonika; 15: 563-72(1970).

A method for simultaneous determination of the Zn and Pb in polymetallic ores is nonspectrometric and selective gamma-gamma. Two sources with gamma rays emitted with energies below and above K_α absorption edge for lead, respectively, are used. The physical principles and the way model measurements were performed are presented. A method is forwarded of interpreting the measured quantities using normalized calibration curves and nomographs based on these curves. Nomographs for ores with a 0 to 15% zinc content and 0 to 4% lead content were constructed. The method is compared with spectrometric measurements. Further measurements and improvements leading to the application of the method in mining are suggested. (auth)

15528 ANALYSIS FOR IMPURITIES BY NUCLEAR SCATTERING. Cohen, B. L.; Moyer, R. A. (Univ. of Pittsburgh). Anal. Chem.; 43: 123-8(Jan 1971).

Use of elastic proton scattering to analyze for impurities in thin samples is investigated. Mass resolutions of one AMU at A≅63 and 10 AMU at A ≈200 are readily achieved. Backgrounds are sufficiently low that 1 part per billion impurities of heavy elements in a light element material are detectable. Sensitivities below one part per million are easily achieved; they can be traded-off against mass resolution to reach the part-per-billion region. (auth)

15529 RAPID PROCEDURE FOR LIQUID SCINTILLATION COUNTING OF ANIMAL TISSUES USING A NITRIC ACID DIGESTION PROCEDURE AND A DIOXANE-BASED SCINTILLATOR. Pfeffer, M.; Weinstein, S.; Gaylord, Janet; Indindoli, Laura (Endo Labs., Garden City, N. Y.). Anal. Biochem.; 39: 46-53(Jan 1971).

The development of a liquid scintillator solvent that can hold up to 4.5 ml of H_2O per 10 ml of solvent is described. This solvent consists of 1% (2-(4'-tert-butylphenyl)-5-(4''-biphenyl)-1,3,4-oxadiazole) and 6% naphthalene in dioxane. A nitric acid digestion system for use in conjunction with this solvent is applicable to a wide range of animal tissues, is relatively rapid, calls for minimum modification from tissue to tissue, and generally yields colorless counting solutions without need for special decolorization techniques. It must be emphasized that this system was designed for ambient temperature operation and is unusable in refrigerated spectrometers. (auth)

15530 RADIOACTIVITY MEASUREMENT IN BIOLOGICAL MICROSAMPLES. Belanger, G. J.; Babineau, L. M.; Despointes, R. H. Int. J. Appl. Radiat. Isotop.; 21: 437-40(1970). (In French).

A quaternary ammonium base is used to render soluble in a scintillator a plasma sample of volume about 30 µl, avoiding the need to heat before counting and the occurrence of self-absorption. The efficiency may be as high as 38%. Details of procedure are given. 4π geometry can be maintained without a carrier. (UK)

Activation Procedures

Refer also to abstracts 15718, 15849, 15850, 15902, 15959, 16278, and 16306.

15531 DETERMINATION OF 28 TRACE ELEMENTS BY ACTIVATION ANALYSIS AFTER SEPARATION BY SOLVENT EXTRACTION AND PRECIPITATION. Schulte, K. E.; Henke, G.; Tjan, K. S. (Univ. Muenster, Ger.). Z. Anal. Chem.; 252: 358-66(1970). (In German).

A method is reported for the determination by activation analysis of 28 elements occurring in organic and biological material in small concentrations and exhibiting as (n,γ)-products of half-life times >10 hours. After irradiation and wet combustion, chemical separation of the elements may be achieved by solvent extraction and precipitation; chemical yields were ascertained on standard-

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ized mixtures. The influence of varying neutron flux was taken into account by cobalt standards. Activity measurement was done by gamma scintillation spectrometry. (auth)

15532 RADIOACTIVATION DETERMINATION OF TANTALUM IN ROCKS AND ORES. Glukhov, G. G.; Gil'bert, E. N.; Torgov, V. G. Radiokhimiya; 12: 534-5(1970). (In Russian).

Tantalum was determined by neutron activation and selective extraction using a 10% solution of α-n-nonylpyridine-N-oxide. Reproducibility of the results lay within ±10 to 15%. (M.C.G.)

15533 NEUTRON-ACTIVATION DETERMINATION OF COPPER IN ROCKS. Glukhov, G. G.; Gil'bert, E. N. Radiokhimiya; 12: 533-4(1970). (In Russian).

Use of extraction for rapid radiochemical purification of copper permitted a sharp increase in the sensitivity of the determination with a negligible complication of the course of the analysis. Dimethylbenzylalkylammonium chloride and β,β'-dichlorodiethyl ether were used for the extraction. The chemical yield of the copper using this method of isolation was 80 to 85%. (M.C.G.)

15534 PHOTOACTIVATION DETERMINATION OF OXYGEN IN COMPOUNDS WITH IODINE. Kuznetsov, R. A.; Grushko, Yu. S.; Kotel'nikov, L. A. Radiokhimiya; 12: 531-3(1970). (In Russian).

Photoactivation analysis was used to monitor the oxygen content of some iodine compounds. It was concluded that the main source of error was in the packing of the sample into the cuvette for irradiation. (M.C.G.)

15535 INTERNATIONAL SYMPOSIUM ON THE APPLICATION OF NEUTRON ACTIVATION ANALYSIS IN OCEANOGRAPHY, BRUSSELS, BELGIUM, 17–22 JUNE 1968. Bruxelles; Institut Royal des Sciences Naturelles de Belgique (1968). 218p. (CONF-680618).

Nine articles are included; separate abstracts were prepared for eight. The remaining article was previously abstracted as NSA 22: 37642. Abstracts only are given for two additional articles, on inorganic chemistry of the ocean and neutron activation analysis of lanthanides in the hydrosphere. One additional article on application of neutron activation analysis to the study of the composition of marine aerosols is listed only by title. Four appendices on typical trace element concentrations in surface ocean waters, trace element concentrations in surface and deep ocean waters, trace element concentrations in marine organisms, and artificial and natural radionuclide concentrations in the ocean and in marine organisms are included. (P.C.H.)

For abstracts of individual papers see: 15536–15543.

15536 TRACE ANALYSIS OF A FEW ELEMENTS BY NEUTRON ACTIVATION COMPARISON WITH ATOMIC ABSORPTION AND ISOTOPE DILUTION. Boudin, A.; Deutsch, S.; Hanappe, F.; Vosters, M. (Univ. Libre, Brussels). pp 13-21 of International Symposium on the Application of Neutron Activation Analysis in Oceanography, Brussels, Belgium, 17–22 June 1968. Bruxelles; Institut Royal des Sciences Naturelles de Belgique (1968).

From International Symposium on the Applications of Neutron Activation Analysis in Oceanography, Brussels, Belgium. See CONF-680618.

The geochemistry of trace elements of common interest in oceanography, geology, and glaciology, and techniques and methods applied in the two latter fields are discussed. The advantages of activation analysis of lutetium, zirconium, and hafnium based on short half-life nuclides are given. The concordance of the results of lutetium, nickel, and manganese in the microgram or lower range by activation analysis, atomic absorption, and isotope dilution demonstrates the absence of systematic errors and uncontrolled contaminations for each method. Low contamination levels are achieved by storage and irradiation of frozen samples and the use of specially tested clean material in dust-free laboratories. (auth)

15537 APPLICATION OF THE NEUTRON ACTIVATION ANALYSIS IN THE RADIOECOLOGY. Feldt, W. (German Federal Board of Fisheries Research, Hamburg). pp 25-39 of International Symposium on the Application of Neutron Activation Analysis in Oceanography, Brussels, Belgium, 17–22 June 1968. Bruxelles; Institut Royal des Sciences Naturelles de Belgique (1968).

From International Symposium on the Applications of Neutron Activation Analysis in Oceanography, Brussels, Belgium. See CONF-680618.

The usefulness of neutron activation in different branches of radioecology is discussed. The results of some determinations of Fe, Zn, Mn, Co, and Cu in deep sea organisms are presented, by means of which the difficulties of sampling and storage can be seen. The questions of further sampling and storage are also discussed. Also the structural and technical facilities of the new activation laboratory, just under construction, will be presented. (auth)

15538 PRE-TREATMENT OF SEA-WATER SAMPLES FOR THE ACTIVATION ANALYSIS OF SOME TRACE ELEMENTS. Fukai, R. (International Lab. of Marine Radioactivity, Monaco). pp 41-57 of International Symposium on the Application of Neutron Activation Analysis in Oceanography, Brussels, Belgium, 17–22 June 1968. Bruxelles; Institut Royal des Sciences Naturelles de Belgique (1968).

From International Symposium on the Applications of Neutron Activation Analysis in Oceanography, Brussels, Belgium. See CONF-680618.

In connection with the application of neutron activation analysis to marine science, problems caused by the introduction of pretreatment on water samples before irradiation are discussed. Pre-treatment procedures such as phase separations and chemical separations are considered from general points of view. Separations of organically bound fractions of trace elements and rates of chemical reactions with extremely dilute concentrations of trace elements in a sea water medium are also discussed briefly. As a conclusion, the necessity of cross-checking of results obtained through various methods of analysis has been stressed, with the suggestion that neutron activation techniques may serve as reference techniques in many cases. (auth)

15539 ACTIVATION ANALYSIS LABORATORY OF THE JOINT NUCLEAR RESEARCH CENTER OF THE EUROPEAN COMMUNITY AT ISPRA, ITALY, AND ITS POTENTIAL IN OCEANOGRAPHIC RESEARCH. Girardi, F. (CCR, Ispra, Italy). pp 59-70 of International Symposium on the Application of Neutron Activation Analysis in Oceanography, Brussels, Belgium, 17–22 June 1968. Bruxelles; Institut Royal des Sciences Naturelles de Belgique (1968).

From International Symposium on the Applications of Neutron Activation Analysis in Oceanography, Brussels, Belgium. See CONF-680618.

A description of the facilities and the methodologies developed for the activation analysis laboratory of the C.C.R. at Ispra is given. Special attention is given to the new "61P" irradiation system, which is composed of six irradiation channels, a fast pneumatic system, and a thirty-position storage and transfer rack. The advantages of the 61P in oceanographic applications are stressed. Studies on the inorganic ion separators (IIS) are also included. The potential of the IIS for simple and fast radiochemistry is outlined, with a special reference to the problem of sodium elimination. The possibilities of computer-coupled radiochemistry are also discussed. The counting system of the laboratory is also described. It is composed of two complete gamma spectrometers with various detectors (including a 47-ml Ge(Li) semiconductor), two pneumatic sample changers, and different read-out units. The whole system can be operated by a control console, which enables one operator to use it with a minimum run-around time. The work under way for connecting on-line the counting system to an IBM-360/65 computer is described. The computer programs are briefly outlined. (auth)

15540 TRACE ELEMENT ANALYSIS OF AQUATIC ORGANISMS. Merlini, Margaret (EURATOM, Ispra, Italy). pp 75-101 of International Symposium on the Application of Neutron Activation Analysis in Oceanography, Brussels, Belgium, 17–22 June 1968. Bruxelles; Institut Royal des Sciences Naturelles de Belgique (1968).

From International Symposium on the Applications of Neutron Activation Analysis in Oceanography, Brussels, Belgium. See CONF-680618.

The interest in the amounts and distribution of stable elements in aquatic organisms has increased with the recognition of the importance of such information (especially in connection with radiocontamination), and with the development of analytical methods of greater sensitivity. Using neutron activation analysis as the method of choice, five elements were determined over a period of one year in fishes, macrophytes (water plants), mollusks, and the water of Lake Maggiore (Lago Maggiore), North Italy. The total range and median for Mn, Zn, Cs, Co, and Sc are reported and compared with ranges for the same elements found in the literature for seawater and marine organisms. Some of the factors involved in the accumulation of trace elements by aquatic organisms are discussed. (auth)

15541 FINE STRUCTURE ANALYSIS OF TRACE ELEMENTS IN SEA WATER SAMPLES: MULTIPARAMETRIC SPECTROMETRY AFTER THERMIC NEUTRON ACTIVATION. Lacroix, R.

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(Institut Royal des Sciences Naturelles de Belgique, Brussels). pp 103-16 of International Symposium on the Application of Neutron Activation Analysis in Oceanography, Brussels, Belgium, 17–22 June 1968. Bruxelles; Institut Royal des Sciences Naturelles de Belgique (1968).

From International Symposium on the Applications of Neutron Activation Analysis in Oceanography, Brussels, Belgium. See CONF-680618.

A complete description is given of a new laboratory built for the neutron activation analysis for trace elements in seawater samples and the method used. The first results of the activation of samples of the Mediterranean Sea by thermal neutrons are discussed. It is shown how the conclusion of these experiments brought about the necessity of the extension of the laboratory. The acquisition of a multi-programming computer and a neutron generator for next year is explained. The conception of a logical program of analysis with this equipment joined to a double chain of multichannel analyzers (a 4096 and a 1024 one) is discussed. (P.C.H.)

15542 APPLICATION OF NEUTRON ACTIVATION ANALYSIS TO THE STUDY OF TRACE ELEMENTS IN UNITED KINGDOM COASTAL WATERS. Preston, A.; Dutton, J. W. R. (Ministry of Agriculture, Fisheries, and Food, Lowestoft, Eng.). pp 117-42 of International Symposium on the Application of Neutron Activation Analysis in Oceanography, Brussels, Belgium, 17–22 June 1968. Bruxelles; Institut Royal des Sciences Naturelles de Belgique (1968).

From International Symposium on the Applications of Neutron Activation Analysis in Oceanography, Brussels, Belgium. See CONF-680618.

A review on the major radionuclides represented in marine disposal and the various techniques available for the determination of their stable counterparts has resulted in the decision to use neutron activation and atomic absorption spectrophotometry for the analysis of a selection of metal trace elements in multicompartment concentration processes typical of United Kingdom coastal waters. The application of neutron activation analysis to these nuclides and materials is discussed against the background of relevant radiochemical and radiometric techniques. (auth)

15543 SOME PROGRAMMES FOR THE RESOLUTION OF GAMMA RAY SPECTRA INTO THEIR COMPONENTS. Pagden, I. M. H. (Bedford Inst. of Oceanography, Quebec). pp 213-18 of International Symposium on the Application of Neutron Activation Analysis in Oceanography, Brussels, Belgium, 17–22 June 1968. Bruxelles; Institut Royal des Sciences Naturelles de Belgique (1968).

From International Symposium on the Applications of Neutron Activation Analysis in Oceanography, Brussels, Belgium. See CONF-680618.

Gamma ray detectors, Ge(Li), are now being used for the observation of gamma spectra of various activation products. One of the problems involved is the determination of those radioisotopes thought to be present in a mixture and their activities. The programs described use published nuclear data and spectrometric criteria in calculations which enable a user to evaluate possible radioisotopes in a mixture. The program output lists activities of isotopes believed to be present in a sample. (auth)

15544 CONTRIBUTION TO THE STUDY OF THE SEPARATION AND DETERMINATION OF TRACES OF HAFNIUM IN SCANDIUM. Balsenc, L.; Beeler, R.; Haerdi, W. (Univ., Geneva). Chimia (Aarau); 24: 420-1(15 Dec 1970). (In French).

A rapid destructive method for the determination of traces of hafnium in scandium is discussed. The separation of Hf and Sc as sulfuric complexes is performed on an anion-exchanger. After separation, Hf is determined by neutron activation analysis. Based on experimental results an hypothesis was made about the presence of a fourth sulfuric complex of hafnium. (auth)

15545 QUANTITATIVE DETERMINATION OF Ca, Na, Al, Mg, AND Cl IN NORMAL ENAMEL AND DENTINE BY NEUTRON ACTIVATION AND HIGH RESOLUTION GAMMA SPECTROMETRY. Retief, D. H.; Cleaton-Jones, P. E.; Turkstra, J. (Univ. of Witwatersrand, Johannesburg. South African Medical Research Council, Johannesburg). J. Dent. Ass. S. Afr.; 25: 188-92(Jun 1970).

A method is described for the determination, by thermal neutron activation and high resolution γ spectrometry, of the concentration of some of the elements that give rise to short-lived radioisotopes in normal human enamel and dentine: Ca, Na, Al, Mg, and Cl. The findings for Ca, Mg, and Cl were similar to those published previously by others. In the case of Al, however, its concentration in both tissues was found to range from 10 to 100 ppM by others using mass spectrometry, whereas in the present investigation its mean concentration in dentine was 68.6 ppM and 236 ppM in enamel. (P.C.H.)

15546 RADIOACTIVATION BY ^{3}He BOMBARDMENT: A PRACTICAL ANALYTICAL SYSTEM. Lamb, James Francis. Berkeley, Calif.; Univ. of California (1969). 232p. University Microfilms Order No. 70-17,599.

Thesis.

Charged-particle activation analysis using 1 to 30-MeV ^{3}He ions as the nuclear reaction-inducing particle is discussed with emphasis on the light elements, especially oxygen. Definitions and expressions fundamental to charged-particle activation analysis are given with brief discussions. Also included are convenient ^{3}He activation analysis reference curves for estimating Coulomb barriers and the effects of Rutherford scattering upon the incident beam. Range-energy tables for ^{3}He ions in nongaseous targets of the stable isotopes of all elements and an extensive Q-value table for the more important ^{3}He-induced reactions appear as appendices. A summary of excitation functions and reaction data for ^{3}He induced reactions in Be, B, C, N, O, F, Na, Mg, Al, Si, Ca, Ti, Fe, Ni, Cu, Ge, Ta, and Au is given, which contains experimental measurements as well as literature data. All the excitation functions were re-drawn to the same scale to permit convenient comparison. A brief discussion of the recognizable trends in the excitation functions for the more important ^{3}He-induced reactions follows the experimental data. The results of several analyses illustrating special methods and applications of ^{3}He activation analysis are given. These include simultaneous isotopic analysis of ^{16}O and ^{18}O and the preparation of thick Ta_2O_5 oxygen standards, surface depth profile analysis of oxygen in silicon, use of matrix activation as an internal normalization standard in the analysis of oxygen in iron and nickel, and the use of Au, Pt, and Ta as target supports and cover foils. The report is concluded with a discussion of the applicability, interference, sensitivity, and unique features of ^{3}He activation analysis. (auth)

15547 ACTIVATION ANALYSIS OF TRACE IMPURITIES IN SILICON. De Corte, Frans. Ghent; State Univ. of Ghent (1970). Thesis.

The trace impurities P, Au, Sb, Ga, Fe, Tl, Na, K, Sc, Sm, Eu, La, Cr, Co, As, In, Zn, Cu, W, Mo, Sn, and Ta were determined in high-purity silicon by means of destructive thermal neutron activation analysis. The element P was determined in separate silicon samples. After irradiation, addition of carrier and dissolution of the matrix, P was isolated as ammonium phosphomolybdate and the ^{32}P β^- activity was measured with a Geiger–Müller tube or a plastic scintillator. The second-order interference ^{30}Si (n, γ; β^-; n, γ) ^{32}P was computed as a function of the thermal and epithermal neutron fluxes and of the irradiation time. To enable these calculations, it was necessary to determine the activation resonance integral of the reaction ^{30}Si (n,γ) ^{31}Si, for which a value of 0.73 barn was found. After correction for the apparent P concentrations, real P contents from 6.6 ppM down to 1.5 ppB were detected. A scheme for the simultaneous determination of 21 trace elements was developed. To avoid losses of As during the removal of Si, a teflon-made destruction apparatus for the volatilization of the silicon matrix from HF/HNO_3 medium was applied. After destruction, a first group separation was carried out by simultaneous extraction of Au (III), Sb (V), Ga (III), Fe (III) and Tl (III) from HCl 7.75 N with diisopropyl ether. Au, Sb, Ga and Fe were determined by means of mixed NaI (Tl) γ-spectrometry using their isotopes ^{198}Au, ^{122}Sb, ^{72}Ga, and ^{59}Fe. ^{204}Tl, a pure β^- emitter, did not interfere and was afterwards isolated from the organic layer as $TlClO_4 \cdot 4CS(NH_2)_2$ and counted β^- spectrometrically. The elements remaining in the aqueous phase were separated using anion exchange. All these elements or groups were counted γ spectrometrically on Ge (Li) or NaI (Tl) detectors. As a multielement activation analysis causes many problems with respect to the standards, a triple comparator method, using ^{60}Co, ^{114m}In, and ^{198}Au was developed. Using this method it was possible to calculate the standard activities from the comparator activities and from the ratio of thermal to epithermal neutron flux. These flux ratios were calculated from the absolute activities of the comparators. It was found that this technique could be used in replacement of the standard without decreasing the accuracy. Silicon of 5 different purity levels was analyzed. Only Au, Sb, As, Cu, Ta, Na, and Sc were found in some of the samples. The upper concentration limits were calculated and were varying from 10^{-4} ppB for Au to 20 ppB for Fe. (Diss. Abstr. Int., B)

15548 SUBSTOICHIOMETRIC DETERMINATION OF TUNGSTEN BY NEUTRON ACTIVATION AND ISOTOPE DILUTION ANALYSIS. Baishya, N. K.; Heslop, R. B. (Univ. of Manchester, Eng.). Anal. Chim. Acta; 53: 87-94(Jan 1971).

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Extraction into chloroform with substoichiometric amounts of toluene-3, 4-dithiol was studied for the determination of tungsten. The effect of interfering metal ions was investigated. Based on this, tungsten in high-speed steel was determined by isotope dilution and in aluminum by neutron activation. (auth)

15549 WATER TRACING WITH SOLUBLE METAL CHELATES AND NEUTRON-ACTIVATION ANALYSIS: A LABORATORY AND FIELD STUDY. Hanson, Peter James. Corvallis, Oreg.; Oregon State Univ. (1970). 110p. University Microfilms Order No. 70-22,762.

Thesis.

Research on the application of soluble, metal chelates for water tracing using thermal neutron activation analysis for tracer determination led to the development of several tracers with promising solution stabilities (conservative behavior) and determination sensitivities. The solution stabilities of the ethylenediamine tetraacetic acid (EDTA) and the diethylenetriaminepentaacetic acid (DTPA) chelates of the activable elements Cr, Co, Eu, In, Sb, Sc, and Tb were evaluated in a series of laboratory, radiotracer experiments conducted under simulated field conditions. They showed that: chelation of metals produces highly conservative solution behavior, DTPA is generally better than EDTA for improving tracer behavior, nonchelated metals are rapidly sorbed onto sediments, and chelation reduces sorption of metals onto sediments. Field tests of EuDTPA, TbDTPA, InDTPA, and Rhodamine B fluorescent dye in a small eastern Washington stream demonstrated that the metal chelates have significantly improved solution stabilities in natural water compared to widely used Rhodamine B. Minimum detection levels in natural waters for the activable tracers were determined to be 0.075 ppB for Eu, 0.10 ppB for Tb and 0.55 ppB for In in comparison to 0.49 ppB for Rhodamine B. Associated determination uncertainties (one standard deviation) amount to ±12% for Eu at 12 ppB, ±12% for Tb at 13 ppB, and ±13% for In at 10 ppB compared to ±7.3% for Rhodamine B at 1 to 10 ppB. Activation procedures are feasible, which decrease the minimum detection levels to 0.0015 ppB for Eu, 0.0019 ppB for Tb and 0.0057 ppB for In in comparison to 0.075 ppB for Rhodamine B. Anion-exchange proved uniquely suited for recovery and concentration of metal-chelate tracers from natural water and as a low background irradiation and counting matrix. A method evaluation and economic analysis clarify the potential application of activable metal chelates for water tracing. (Diss. Abstr. Int., B)

15550 USE OF THE CYCLOTRON FOR WHOLE BODY NEUTRON ACTIVATION ANALYSIS: THEORETICAL AND PRACTICAL CONSIDERATIONS. Chamberlain, M. J.; Fremlin, J. H.; Holloway, I.; Peters, D. K. (Univ. of Birmingham, Eng.). Int. J. Appl. Radiat. Isotop.; 21: 725-34(Dec 1970).

Conditions were established for producing a suitable neutron flux for carrying out sequential neutron activation analyses for total body calcium in living subjects. A cyclotron was used as a neutron source, by bombarding a thick lithium target with 10.2-MeV protons, the resulting neutron spectrum being continuous from 0.1 to about 8.0 MeV, with a peak at 3.5 MeV. This choice of neutron energy avoids serious interfering reactions. A uniform field of fast neutrons large enough to accommodate a patient was achieved without the adoption of positions impracticable to ill patients; and by suitable moderation of the fast neutrons by external moderators and the body itself, a sufficiently uniform flux of thermal neutrons is created throughout the body. A fast neutron dose of order 1 rem is given to the patients. The reasons for not attempting to make absolute measurements of calcium content are given, and the method by which changes of calcium content with time can be measured in an individual using a Ca/Na ratio is discussed. (auth) (UK)

15551 INTERFERENCE-FREE, ACTIVATION ANALYSIS DETERMINATION OF SPECIAL TRACE ELEMENTS WITH HIGHLY SELECTIVE 2-FOLD AND 3-FOLD γ-COINCIDENCE ARRANGEMENTS WITH CONSIDERATION OF THE MOST IMPORTANT INTERFERENCE FACTORS. Woelfle, R.; Herpers, U. (Kernforschungsanlage, Juelich, Ger. Univ., Cologne). Mikrochim. Acta; No. 5, 933-40(1970). (In German).

Nondestructive neutron activation analysis of copper traces in the ppM- and ppB-range was studied by means of an improved and highly selective γ,γ-coincidence, using the ^{64}Cu-annihilation radiation, with particular reference to interfering pair production. For 22 interfering nuclides the relative pair production rate was calculated. A method for detection, reduction, and correction was developed and applied to the determination of copper contents in standard rocks, stony meteorites, and molybdenites. Especially the ^{24}Na interference was successfully overcome. For a number of nuclides, emitting three or more γ-quants either in cascade or one γ-quantum together with the annihilation radiation, it was shown that triple coincidence leads to a considerable further improvement in selectivity combined with a reduction of random coincidences. The triple coincidence was applied to the direct determination of iridium traces (down to 20 ppB) in iron meteorites. (auth)

15552 NEUTRON ACTIVATION ANALYSIS FOR DETERMINATION OF ^{148}Nd IN RARE EARTHS. Ruf, H.; Baeckmann, A. v.; Gantner, E. (Kernforschungszentrum, Karlsruhe, Ger.). Mikrochim. Acta; No. 5, 1029-38(1970). (In German).

Neodymium-148 was determined in fission product rare earths for the purpose of burnup analysis of irradiated nuclear fuels employing neutron activation analysis. Following ion exchange chromatographic separation of other lanthanides, the fission product neodymium was irradiated in the thermal column of the FR 2 and the gamma activity of the ^{149}Nd was measured without any additional chemical workup. Known amounts of ^{148}Nd (the pure isotope) were used as standard samples. The chemical yield after the separation was determined gamma spectrometrically using the carrier-poor ^{147}Nd as spike. (auth)

15553 PHOTON ACTIVATION ANALYSIS: A REVIEW. Lutz, George J. (National Bureau of Standards, Washington, D. C.). Anal. Chem.; 43: 93-103(Jan 1971).

Prior to the availability of high-energy electron accelerators, photon activation analysis was limited to the determination of deuterium and beryllium with isotopic gamma sources. During the past 15 years, however, the development of high-current cyclic and linear electron accelerators has made possible many analyses not readily accomplished by other methods. These include the determination of carbon, nitrogen, and oxygen at levels well below 1 μg. Topics discussed include: the determination of beryllium and deuterium with isotope sources; accelerator-produced photons and nuclear considerations in photon activation analysis; the determination of carbon, nitrogen, and oxygen; the determination of heavier elements, with emphasis on biological, geochemical, oceanographic, and forensic matrices; and errors and corrections in photon activation analysis. (auth)

15554 INFLUENCE OF ENERGY DISTRIBUTION IN CHARGED PARTICLE ACTIVATION ANALYSIS. Giroux, J.; Thomas, J. P.; Tran, M. D.; Tousset, J. (Univ. Lyon, Villeurbanne, France). pp 319-29 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The effects of energy distribution upon the activation curves of the reaction producing ^{18}F from oxygen with α-particles were investigated. Experiments were performed with mylar and mica in different beams: one at 35 MeV incident energy with good resolution and the other at 54 MeV with different widths, the origins and importance of which are discussed. Noticeable discrepancies between these activation curves were established according to the different distribution widths, that involve variations between the values for the "equivalent thickness" in the calibration. Moreover, the energy distribution exaggerates the difficulty in eliminating interferences caused by parasitic reactions with thresholds occurring in the matrix. All these terms can be evaluated if the excitation functions of the useful reactions are expressed in a simple analytical form; for an exponential or gaussian function, shape factors are calculated to take account of the slopes of excitation functions and of the widths of energy distributions. (auth) (UK)

15555 CONTRIBUTION TO THE STUDY OF Be, B, C, N, O, AND F DETERMINATION BY p, ^{3}He, AND α ACTIVATION. Engelmann, Ch. (CEN de Saclay, Gif-sur-Yvette, France). pp 328-40 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

From activation curves obtained by irradiating thick targets containing Be, B, C, N, O, and F with p, ^{3}He, and α-particles, it was found that these elements are measurable at concentrations of 10^{-10} to 10^{-9} g/g using 10 μA beams, assuming that there are no interferences from other impurities. B, N, O (by the ^{16}O(p,α)^{13}N reaction, which proves to be much more sensitive than the reaction on ^{18}O) and F may be determined by activation with 15 MeV protons. Be, B, C, and O may be determined by activation with 20 MeV ^{3}He particles, and Be, B, C, N, O and F by activation with 42 MeV α-particles. The curves can also be used to plot graphs which give, as a function of the charged-particle energy, the mag-

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nitude of certain interferences attributable to the formation of the same active isotope from one or several other neighboring elements. From these are deduced the relative selectivity of p, ^{3}He, or α-particles for the determination of one or another of the above elements. The possibilities are summarised in a table showing, for several energies of each of the three particles, the minimum concentrations which are measurable. In addition, the activation curves can be used to predict the production yield of isotopes such as ^{11}C, ^{13}N, and ^{18}F obtained by irradiating thick targets of unspecified composition by weight. (auth) (UK)

15556 EXPERIMENTAL DATA ON THE YIELDS OF ^{11}C, ^{13}N, ^{18}F ISOTOPES USED FOR THE DETECTION OF CARBON, NITROGEN; OXYGEN, AND NEIGHBOURING LIGHT ELEMENT IMPURITIES BY MEANS OF ACTIVATION ANALYSIS WITH DIFFERENT CHARGED PARTICLES (p, d, ^{3}He, α). Krasnov, N. N.; Dmitriev, P. P.; Dmitrieva, S. P.; Konstantinov, I. O.; Molin, G. A. (Inst. of Physics and Power Engineering, Obninsk, USSR). pp 341-53 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF 690924.

Experimental values are given of the yields of ^{11}C, ^{13}N, and ^{18}F isotopes produced by the irradiation of carbon, nitrogen, oxygen, and neighbouring light elements (Be, B, F, Na, Mg, and Al) by protons, deuterons, ^{3}He ions, and α-particles. Experimental data are presented in the form of curves giving the dependence of isotope yields on particle energy (E_p = 22 MeV, E_d = 22 MeV, $E_{^3He}$ = 30 MeV, E_α = 44 MeV). On the basis of these data various methods of detecting carbon, nitrogen, and oxygen impurities by bombardment with the above four types of particles are considered. (auth) (UK)

15557 DETERMINATION OF VANADIUM AND NIOBIUM BY PROTON ACTIVATION. Debrun, J. L.; Barrandon, J. N.; Albert, Ph. (CNRS, Vitry-sur-Seine, France). pp 354-64 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

In most cases, vanadium and niobium cannot be determined at low concentrations by neutron activation, for the half-lives of the radioisotopes are too short or the sensitivity is rather poor. Proton activation was used to reach a high sensitivity for the determination of niobium, e.g., 3×10^{-2} ppM/μA in aluminium, for 1 h irradiation at 30 MeV. The nuclear reaction used is ^{93}Nb(p,n)^{93}Mo. To avoid any risk of interference by the reaction ^{94}Mo(p,pn)^{93}Mo, the energy must be limited to 10 MeV. Under these conditions (10 MeV and 1 h irradiation), the sensitivity is 4×10^{-1} ppM/μA. For vanadium 2.4×10^{-1} ppM/μA can be detected in aluminium by irradiating for 1 h at 30 MeV. The reaction studied is ^{51}V(p,n)^{51}Cr. The interference of chromium by ^{52}Cr(p,pn)^{51}Cr was studied, and it was found that the production of ^{51}Cr from ^{52}Cr can be neglected if $E_p < 15$ MeV. By limiting the proton energy to 15 MeV, the sensitivity does not decrease much; 3.6×10^{-1} ppM/μA can be detected with a 1 h irradiation. By irradiating for several hours, a sensitivity of 10^{-1} ppM/μA can be easily reached for the determination of vanadium with 15 MeV protons and of niobium with 10 MeV protons, the half-lives of ^{51}Cr and ^{93}Mo being 27.8 d and 6.9 h. (auth) (UK)

15558 NEUTRON ACTIVATION ANALYSIS OF RAT BONE: SIMULTANEOUS DETERMINATION OF CALCIUM, CHLORINE, MAGNESIUM, AND SODIUM. Conaway, H. Herschel; Leddicotte, George W.; Kenny, Alexander D. (Univ. of Missouri, Columbia). Anal. Biochem.; 39: 218-27(Jan 1971).

A method for the simultaneous determination of Ca, Cl, Mg, and Na by neutron activation analysis of ashed bone samples was developed. Humeri, removed from 2-month-old male rats, were cleaned, defatted and dried, and ashed at 500°C for 48 hr. The ash was dissolved in dilute HNO_3 and diluted to 10 ml. Aliquots of the bone sample and of a standard solution were irradiated in the University of Missouri nuclear reactor for periods of not more than 50 sec at a flux level of 5.2×10^{13} neutrons/cm^2 sec. The neutron-induced, gamma-emitting radionuclides (^{49}Ca, ^{27}Mg, ^{24}Na, and ^{38}Cl) were analyzed by means of a gamma spectrophotometer. There was good agreement between the Ca, Mg, and Na contents of bone samples determined by neutron activation (mean values of 38.3, 0.84, and 1.08 mg/100 mg ash, respectively) and by atomic absorption (38.3, 0.80, and 1.15 mg/100 mg ash, respectively). Neutron activation analysis yielded a mean value of 0.34 mg/100 mg ash for Cl. Calculation of the Ca/P ratios gave a mean weight ratio of 2.14 and a mean molar ratio of 1.66. (auth)

15559 DETERMINATION OF SILICON BY NEUTRON ACTIVATION ANALYSIS IN LYMPHATIC GLANDS. Miskovits, Gustav; Orban, Eva; Dubay, Miklos; (and others) (Medical Research Clinic, Budapest. Inst. of Chemistry, Budapest). Munkavedelem; 16: 45-7(1970). (In Hungarian).

A method for the neutron activation determination of silicon in human lymphatic glands is described. Tabulated data are given on the silica concentration in the tissues and organs. (R.V.J.)

15560 SODIUM REMOVAL AS AN AID TO NEUTRON ACTIVATION ANALYSIS. Ralston, H. R.; Sato, Elaine S. (Univ. of California, Livermore). Anal. Chem.; 43: 129-31(Jan 1971).

Conditions are described for a method of sodium removal for particular applications to biological and environmental analysis. Irradiated samples were dissolved and passed through the HAP column. The separated fractions of dissolved sample were counted. The ratio between the ^{24}Na retained on the column and that counted in the unseparated fraction was 1.06. The ratio between the sodium counted in the separated sample and that retained on the column was 0.013. (D.P.O.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 15828, 15829, 18100, and 18174.

15561 (IS-2300, pp 7-20) CHEMICAL ENGINEERING DIVISION. Bautista, R. G.; Burkhart, L. E.; Burnet, G.; Shuck, F. O.; Stevenson, F. D. (Ames Lab., Iowa).

From Ceramic Engineering, Chemical Engineering, Chemistry, Mathematics and Computer Science, Metallurgy, Physics, and Reactor Divisions annual summary research report, July 1969–June 1970.

Developments are reported for studies on: D2EHPA as a solvent for separating Sm, Nd, Ce, Y, Ho, Er, and La and also for separating Tm and Yb; liquid-metal diffusion; kinetics of niobium oxychloride chlorination; and uncontrolled growth rate method for preparation of high-purity single crystals. (P.C.H.)

15562 (IS-2300, pp 21-89) CHEMISTRY DIVISION. Angelici, R. J.; Banks, C. V.; Calder, G. V.; (and others) (Ames Lab., Iowa).

From Ceramic Engineering, Chemical Engineering, Chemistry, Mathematics and Computer Science, Metallurgy, Physics, and Reactor Divisions annual summary research report, July 1969–June 1970.

Developments are reported for studies on: low oxidation states of metals; x-ray and neutron diffraction; high-temperature chemistry; chemistry of the heavy transition elements; analytical separations and operations; analytical atomic, molecular, and mass spectroscopy; thermodynamic and magnetic properties of solids; and radiochemistry and activation analysis. (P.C.H.)

15563 (UCRL-Trans-10510) CLASSIFICATION OF THE LANTHANIDES AND ACTINIDES INTO THE PERIODIC SYSTEM. Hardt, H. D. Translated for Univ. of California, Lawrence Radiation Lab., Livermore, from Naturwiss. Rundsch.; 22: No. 7, 302-5(1969). 7p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 20778.

Chemical Properties

Refer also to abstracts 15750, 16411, and 16578.

15564 (IJS-584) HYDRAZINE REDUCTION OF URANIUM HEXAFLUORIDE. Frlec, B. (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Jul 1970. 3p. (CONF-700636-1). Dep. NTIS (U. S. Sales Only).

From Fluorine Chemistry Symposium, Milwaukee, Wisc.

Hydrazine and uranium hexafluoride as pure materials react even below –80°C. The reaction proceeds explosively and the composition of its products is not known for obvious reasons. If the two reactants diluted with nitrogen are brought together in a gas flow at 70°C, hydrazinium (1_+) hexafluorouranate(V) results. If, however, uranium hexafluoride vapor diluted with argon is bubbled through anhydrous hydrazine at room temperature, hydrazinium (1_+) hexafluorouranate(IV) is formed. This latter compound was found by others to be formed also when uranium tetrafluoride was shaken with 3 to 6 M solutions of hydrazinium (1_+) fluoride or when uranium tetrafluoride and hydrazinium (1_+) fluoride were allowed to react in anhydrous hydrazine in a stoichiometrical mole ratio. Thermal decomposition of the isolated

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complex compounds yield uranium tetrafluoride with a high surface area. (auth)

15565 (INR-1212) PERIODICITY OF SOME PROPERTIES OF LANTHANIDES AND ACTINIDES. Fidelis, J.; Siekierski, S. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 12p. Dep. NTIS (U. S. Sales Only).

A summary of work on the regularities observed within the f-electron elements is presented. The regularities revealed first in the separation factor are a result of the particular variation of the standard free energy changes, ΔG^0, with Z for complex formation. In confirmation of general validity of the regularities, results of the review of an ample experimental material on the stability constants for different ligands have been presented. The study has been extended on unit cell volumes, V, for different compounds. Two methods have been developed for studying the changes in both ΔG^0 and V, the separation factor method and the linear interpolation method. In a similar way, available data for the actinides have been treated. Parallelism between the ΔG^0 curves and V curves has been indicated. Three different forms of the periodic table of the f-electron elements have been proposed. An attempt at explanation of this effect on the basis of a quantum mechanical study has been undertaken. (auth)

15566 (ORNL-tr-2422) ON THE THERMAL DISSOCIATION AND SUBLIMATION OF UO_2F_2. Knacke, O.; Lossmann, G.; Mueller, F. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn., from Z. Anorg. Allg. Chem.; 371: 32-7(1969). 7p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 41281.

15567 (ORO-3518-19) ELECTROCHEMICAL STUDIES IN MOLTEN FLUORIDES AND OTHER HALIDES. Progress Report, April 1, 1970-March 31, 1971. Mamantov, Gleb (Tennessee Univ., Knoxville. Dept. of Chemistry). Contract AT(40-1)-3518. 19p. Dep. NTIS.

The reduction of Ti(IV) in molten LiF-NaF-KF at 480 to 500°C was studied voltammetrically and chronopotentiometrically at platinum electrodes. Voltammetric studies of Nb in LiF-BeF_2-ZrF_4 were initiated. The Ni(II)/Ni reference electrode exhibited good stability in molten LiF-NaF-KF and LiF-BeF_2-ZrF_4. The voltammetric characteristics of the ternary eutectic LiF-CaF_2-MgF_2 were investigated at 690°C. The equilibrium constant for the dissociation $2AlCl_4^- \rightarrow Cl^- + Al_2Cl_7^-$ in molten chlorides was determined potentiometrically at 175 to 450°C. Characterization of the HG_3^{3+} ion in chloroaluminates was extended. (M.C.G.)

15568 HEPTAVALENT STATE OF TRANSURANIC ELEMENTS. IX. NEW METHODS OF OBTAINING NEPTUNIUM(VII). THE DISPROPORTIONATION OF NEPTUNIUM(VI) IN ALKALINE MEDIA. Krot, N. N.; Mefod'eva, M. P.; Shilov, V. P.; Gel'man, A. D. Radiokhimiya; 12: 471-7(1970). (In Russian).

It was established that in dilute alkaline solutions, neptunium(VI) is reversibly oxidized by ferricyanide ions to the heptavalent state. The equilibrium constant of the reaction is proportional to $[OH^-]^3$ at a constant value of the ionic strength. The interaction of neptunium(VI) in alkaline media with silver oxides was studied. The lower oxide of silver oxidizes neptunium(VI) to an appreciable degree only in solutions with alkali concentrations above 8 M. In the presence of AgO, on the other hand, the formation of neptunium(VII) was observed in 0.2 M KOH. In 2 to 3M alkali, neptunium(VI) is oxidized almost quantitatively by excess AgO. In alkaline melts neptunium(VI) was rapidly and completely oxidized to the heptavalent state by excess $KBrO_3$ (at 290 to 310°C) and $KClO_3$ (at 390 to 400°C). The interaction of NpO_2 with the indicated oxidizing agents, on the other hand, proceeds slowly and not to completion. In concentrated solutions of alkalies, neptunium(VI) disproportionates to an appreciable degree to neptunium(VII) and (V). The equilibrium constant of this extremely rapid reaction increases sharply with increasing alkali concentration. (auth)

15569 URANATES OF ALKALI METALS. Kovba, L. M. Radiokhimiya; 12: 522(1970). (In Russian).

The compounds were prepared by sintering calculated amounts of lithium, sodium, and potassium carbonates with uranium octoxide. Structures of the compounds were studied. (M.C.G.)

15570 ISOLATION OF NEPTUNIUM(IV) WITH HYDROGEN PEROXIDE. Chaikhorskii, A. A.; Murav'eva, L. P.; Barbanel, Yu. A. Radiokhimiya; 12: 528(1970). (In Russian).

Purification of neptunium and production of Np(IV) using H_2O_2 are discussed. The initial Np(IV) solution was evaporated to dryness, the residue dissolved in HNO_3, and H_2O_2 added to form a precipitate. (M.C.G.)

15571 INDUCED REACTIONS IN RADIOCHEMISTRY. IV. THE CRITERIA OF THE CATALYTIC EFFECT IN INDUCED REACTIONS. Posvol'skii, M. V.; Tsirlin, I. I. Radiokhimiya; 12: 477-80(1970). (In Russian).

Possible aspects of the influence of catalysts on induced reactions are discussed. Three types of catalysts can be distinguished: those that accelerate or decelerate the induced reaction; those that change the reaction yield; and those that combine both of the indicated effects. Examples of catalysts of all three types for the induced reactions Cr(VI) + Red + Pu(IV), where Red represents inducers (arsenite and acetaldehyde), were found experimentally. In the case of a finite time of reaction, for complete characterization of the catalyst it is necessary to study its influence on the rate and on the yield of the reaction. The change in the reaction yield with arbitrarily selected initial conditions cannot serve as a quantitative criterion of the effectiveness of catalysts. (auth)

15572 IONIC RADON SOLUTIONS. Stein, Lawrence (Argonne National Lab., Ill.). Science; 168: 362-4(17 Apr 1970).

Radon was oxidized between -195 and 25°C by chlorine fluorides, bromine fluorides, iodine heptafluoride, and NiF_6^{2-} ion in hydrogen fluoride with the formation of stable solutions of radon fluoride. Electromigration studies showed that the radon was present as a cation, possibly Rn^{2+} or RnF^+, in several conducting solutions. (auth)

15573 SOLUBILITY OF THE NOBLE GASES IN LIQUID SODIUM. Thormeier, Klaus (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Eng. Design; 14: 69-82(Oct 1970).

A novel method has been employed to measure the solubility of argon and helium in liquid sodium as a function of gas partial pressure, temperature, and purity of the sodium. The values obtained can be correlated well with the experimental results available for the few other liquid metal-noble gas systems investigated. Theoretical calculations with an improved hard-sphere model also confirmed the experimental results derived. This allows a prediction also of the solubility of xenon in sodium. Some safety problems closely connected with the solubility of noble gases in the reactor coolant sodium are dealt with by the example of the German 300 MW(e) liquid metal fast breeder reactor (SNR). (69 references) (auth)

15574 KINETICS AND MECHANISMS OF THE REDUCTION OF COBALT(III) COMPLEXES BY URANIUM(III) IONS. Wang, Robert T.; Espenson, James H. (Ames Lab., Iowa). J. Amer. Chem. Soc.; 93: 380-6(27 Jan 1971).

Kinetics studies were carried out on the reduction of Co(III) complexes by U^{3+} in perchloric acid solutions. The $Co(NH_3)_5X^{2+}$-type complexes react at relative rates strongly suggesting an inner-sphere mechanism, on the basis of the extent of stabilization of the transition state by different X groups. For X = H_2O the $[H^+]$ dependence suggests than an OH-bridged precursor complex is formed, the stability of which has a marked effect on the reaction kinetics. $Co(NH_3)_6^{3+}$ reacts by an outer-sphere mechanism and its reaction is strongly catalyzed by free anions, most markedly by F^- and NCS^-. The complexes $Co(NH_3)_5NO_3^{2+}$ and $Co(NH_3)_5NO_2^{2+}$ suffer ligand reduction as well as Co(III) reduction. (auth)

15575 POTENTIOMETRIC STUDY ON URANYL ARSENITES AS A FUNCTION OF pH. Saxena, R. S.; Prasad, Shiva; Mittal, M. L. (Malaviya Regional Engineering Coll., Jaipur, India). J. Chem. U.A.R.; 12: 275-8(1969).

Direct and reverse potentiometric titrations between uranyl nitrate and sodium arsenites give the composition of uranyl arsenites at different pH levels. (D.P.O.)

15576 EFFECT OF CONCENTRATION UPON THE CHROMATOGRAPHIC BEHAVIOUR OF TECHNETIUM IN CONCENTRATED HYDROCHLORIC ACID. Williams, M. Jean; Deegan, T. (Sefton General Hospital, Liverpool). J. Chromatogr.; 54: 123-9(6 Jan 1971).

The chromatographic behavior of various concentrations of technetium in 11.4 M HCl was studied on Whatman No. 3MM and DE-81 papers with 0.6 M and 1.2 M HCl, respectively, as developing solvents. Within the concentration range, 0.5 to 2.0 mg per ml, results were similar to those already documented. In addition, two further species were detected, one appearing at concentrations above 2 mg per ml, and the other at concentrations below 0.1 mg per ml. The possible structures of these two species are discussed. (auth)

15577 HALOGENO-, OXOHALOGENO-, AND ETHOXYHALOGENO-COMPLEXES OF QUINQUEVALENT PROTACTINIUM, URANIUM, NIOBIUM, AND TANTALUM. Brown, D.; Rickard, C. E. F. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., A; No. 1, 81-7(1971).

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Metal penta-chlorides and -bromides react with tetraethylammonium chloride or triphenylphosphine oxide (tppo) in anhydrous ethanol to yield ethoxyhalogeno-complexes of the types $NEt_4[M(OEt)_2X_4]$ and $M(OEt)_2X_3$, (tppo), respectively (M = Pa, Nb, or Ta; X = Cl or Br). In the presence of an excess of tetraethylammonium chloride reactions involving niobium(V), but not those involving protactinium(V) or tantalum(V), result directly in the formation of oxopentahalogeno-complexes, $[NEt_4]_2[NbOX_5]$. Analogous protactinium(V) complexes and $[PaOCl_3(tppo)_2]$ and $[PaOBr_3(tppo)_2]$ crystallise when the appropriate ethoxy-complex and either tetraethylammonium chloride or triphenylphosphine oxide are heated with methyl cyanide containing ca. 0.5% water. These are the first examples of complexes containing the Pa=O group. Pentahalide complexes of the type $[MX_5(tppo)_2]$ (M = Pa and U) are obtained from reactions in anhydrous methyl cyanide or methylene dichloride. Some chemical properties, conductivity studies, and i.r. spectral and x-ray diffraction results are reported. (auth) (UK)

Isotope Effects and Exchange

Refer also to abstracts 15675, 15707, 15751, 16022, and 16500.

15578 (NYO-1725-39) MECHANISMS OF ACID-BASE CATALYSIS AND STUDIES IN DEUTERIUM OXIDE AS SOLVENT. Technical Progress Report, January 1, 1970–December 31, 1970. Long, F. A. (Cornell Univ., Ithaca, N. Y. Dept. of Chemistry). 31 Dec 1970. Contract AT(30-1)-1725. 10p. Dep. NTIS.

Studies were made on proton transfer characteristics of cyanocarbon acids. An isotope effect was observed in heavy water. (M.C.G.)

15579 CONCERNING THE ISOTOPIC EXCHANGE OF BROMINE IN THE BROMIDE ANALOG OF ZEISE'S SALT. Grinberg, A. A.; Kuz'mina, M. A. Radiokhimiya; 12: 496-500(1970). (In Russian).

A freshly prepared solution of Zeise's salt $[K(PtC_2H_4Br_3)]$ was mixed with a solution of $K^{82}Br$. Aliquot portions of the solution were collected at definite time intervals, the complex ion precipitated, and the β particles counted. The effects of concentration of the complex salt, the concentration of extrasphere bromine, and temperature were determined. (M.C.G.)

15580 CERTAIN RULES OF DISTRIBUTION OF TRACE IMPURITIES IN THE CRYSTAL HYDRATES OF SODIUM METASILICATE. I. INVESTIGATION OF HETEROGENOUS ISOTOPIC EXCHANGE OF SODIUM METASILICATE NONAHYDRATE. Babayan, S. G.; Arutyunyan, A. M. Radiokhimiya; 12: 417-23 (1970). (In Russian).

The heterogeneous isotopic exchange (^{22}Na) of sodium metasilicate nonahydrate with a saturated solution was investigated. The possible mechanism of the exchange of sodium ions was evaluated. The experimental data can be explained satisfactorily with the assumption of a dominant role of water of crystallization in the exchange reaction. (auth)

15581 CERTAIN RULES OF DISTRIBUTION OF TRACE IMPURITIES IN THE CRYSTAL HYDRATES OF SODIUM METASILICATE. II. INVESTIGATION OF HETEROGENEOUS ISOTOPIC EXCHANGE OF SODIUM, DEUTERIUM, AND TRITIUM IN SATURATED SOLUTIONS WITH STABILIZED CRYSTALS OF $Na_2SiO_3.9H_2O$. Babayan, S. G.; Arutyunyan, A. M. Radiokhimiya; 12: 424-9(1970). (In Russian).

The isotopic exchange of ^{22}Na, deuterium, and tritium from saturated solutions with stabilized crystals of sodium metasilicate nonahydrate was investigated. Water participates in the process of exchange with the solid phase in an amount exceeding the water of crystallization. The number of water molecules participating in exchange was estimated. It was hypothesized that the periodic enrichment and impoverishment of the solid phase with H_2O of the saturated solution is evidently associated with the temporary aquation of the crystallizing substance. (auth)

15582 COMPLEMENTARY SHOCK TUBE TECHNIQUE STUDY OF THE EXCHANGE OF HYDROGEN CHLORIDE AND DEUTERIUM. Kern, R. D. Jr.; Nika, G. G. (Louisiana State Univ., New Orleans). J. Phys. Chem.; 75: 171-80(21 Jan 1971).

Kinetic data for the homogeneous exchange of equimolar mixtures of hydrogen chloride and deuterium in the presence of an inert gas diluent were obtained by the analysis of infrared emission profiles of HCl and DCl and time-resolved mass spectra of m/e 36 and 37. The reaction was studied behind reflected shock waves over a temperature range of 1700 to 2800°K, a total density variation of 1.7 to 4.0×10^{-6} mol/cm^3, and observation times of 500 to 750 μsec. Equilibrium amounts of HCl and DCl were observed in several of the experiments performed at higher temperatures. Both argon and neon were used separately as diluents. The results from the infrared emission shock tube and the time-of-flight mass spectrometer shock tube were in agreement within one standard deviation of the Arrhenius plots. The rate of product formation was found to be nonlinear with respect to time. The formation of the mole fraction of DCl [$f_{DCl} = (DCl)_t/(HCl)_0$] using both sources of data is represented by the equation $\{1 - f_{DCl}[1 + (f_{HCl}/f_{DCl})_{eq}]\} = \exp[-k(M)t^2]$, where $k = 10^{16.12 \pm 0.30} \exp(-34{,}340 \pm 3130/RT)$, cm^3 mol^{-1} sec^{-2}. When the rate is expressed on a concentration basis, the combined order dependence of the reactants was shown to be consistent with a value of one. The difficulties in explaining the rate law in terms of an atomic or molecular mechanism are discussed. (auth)

15583 HYDROGENATION OF ETHYLENE OVER COBALT OXIDE. Tanaka, Ken-ichi; Nihira, Hirohisa; Ozaki, Atsumu (Tokyo Inst. of Tech.). J. Phys. Chem.; 74: 4510-17(24 Dec 1970).

Cobalt oxide evacuated at 400 to 450°C showed an extremely high initial catalytic activity for the hydrogenation of ethylene. However, its activity decreased as the reaction proceeded. It was found that the reduction in the activity was caused by the irreversible adsorption of hydrogen and that such hydrogen did not participate in the isotopic equilibration of H_2 and D_2 and in the hydrogenation of ethylene. In order to monitor the behavior of hydrogen and ethylene on catalysts during the hydrogenation of ethylene, the volumetric adsorption measurement during catalysis, the addition of D_2 to ethylene, the reaction of mixture of D_2 and H_2 with ethylene, and the reaction of hydrogen with mixture of C_2H_4 and C_2D_4 were carried out over three samples of Co_3O_4 catalysts. Both the hydrogenation of ethylene and the equilibration of $H_2 - D_2$ occur on the same active sites. These sites are occupied by ethylene during the hydrogenation of ethylene. Hydrogen does not randomize before it reacts, but ethylene undergoes complete isotopic self-mixing before it reacts with hydrogen. Probable mechanisms for the hydrogenation of ethylene are discussed. (auth)

15584 VIBRATIONAL ASSIGNMENTS AND THERMODYNAMIC FUNCTIONS FOR CIS- AND TRANS-1,2-DIFLUORO-1-CHLOROETHYLENES. Craig, Norman C.; Evans, David A.; Piper, Lawrence G.; Wheeler, Vicki L. (Oberlin Coll., Ohio). J. Phys. Chem.; 74: 4520-7(24 Dec 1970).

Complete assignments of the vibrational fundamentals of cis- and trans-CFCl=CFH and CFCl=CFD were obtained from infrared and Raman spectra. For cis-CFCl=CFH the fundamentals are: (a′) 3137, 1716, 1326, 1159, 1112, 854, 480, 361, and 224 cm^{-1}; (a″) 776, 523, and 255 cm^{-1}. For trans-CFCl=CFH the fundamentals are: (a′) 3120, 1708, 1290, 1196, 1150, 696, 578, 397, and 200 cm^{-1}; (a″) 776, 467, and 310 cm^{-1}. For the cis-to-trans reaction at 591°K, the equilibrium constant is 0.932 ± 0.022. From a rigid rotor, harmonic-oscillator treatment $\Delta S^\circ_{591} = -0.12 \pm 0.26$ cal/mol °K, and ΔE_0° (electronic) = 80 ± 260 cal/mol with the cis isomer having the lower energy. Also, $\Delta H^\circ_{591} = 10 \pm 160$ cal/mol. (auth)

15585 ELECTROLYTE EFFECTS ON THE HYDROLYSIS OF ACETALS AND ORTHO ESTERS. Bunton, C. A.; Reinheimer, J. D. (Univ. of California, Santa Barbara). J. Phys. Chem.; 74: 4457-64(24 Dec 1970).

For hydrolysis in aqueous hydrochloric acid the relative reactivities are 1,1-diethoxyethane, 1; 2,2-diethoxypropane, 2200; triethyl orthoformate, 680; and triethyl orthoacetate, 19,000. The kinetic solvent isotope effect for triethyl orthoacetate $k_{H_2O}/k_{D_2O} = 0.54$ is intermediate between the values for tetraethyl orthocarbonate and triethyl orthoformate. Salt effects upon the rates of acid hydrolysis and the activity coefficients of the substrates have been used to calculate the salt effects upon the activity coefficients of the transition state relative to an anilinium ion and the tri-p-anisyl carbonium ion, and the activity coefficients of the transition state and the anilinium ion are very similar. The salt effects on the transition states relative to those of the anilinium ion generally decrease in the sequence orthoacetate > orthoformate > ketal > acetal. These results suggest that the structures of the transition states are close to those of the conjugate acids and are consistent with a mechanistic change from A1 to A-SE2 in going from acetal to ortho ester. (auth)

15586 MECHANISM OF HYDROLYSIS OF DIAZOACETATE ION. Kreevoy, Maurice M.; Konasewich, Dennis E. (Univ. of Minnesota, Minneapolis). J. Phys. Chem.; 74: 4464-72(24 Dec 1970).

The hydrolysis of potassium diazoacetate to potassium glycolate uses an A-1 mechanism in strongly basic solution but switches to an A-SE2 mechanism in less basic or acidic solution. These conclusions are supported by the form of the rate law and the variation

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in solvent isotope effect with solution basicity. The competitive isotope effects, κ_H/κ_T, for H^+, CH_3COOH, and H_2O as acids are 8.1, 12.4, and 3.0, respectively. The Swain–Schaad relations correctly predict the relative magnitudes of κ_H/κ_T and κ_D/κ_T when H^+ is the acid, and a κ_H/κ_D of 4.2 is estimated. Comparison of κ_H/κ_D for H^+ and H_2O with the solvent isotope effects permits the calculation of α_i values, analogous to the Brønsted α, for H^+ and H_2O. They are 0.30 and 0.89, suggesting that the Brønsted plot will be curved. Upper limits of about 10^7 and 10^5 sec^{-1}, respectively, can be inferred for the rate constants for the spontaneous loss of N_2, and the loss of H^+ to H_2O, from $^+N_2CH_2COO^-$. The upper limit for the acid dissociation constant of this ion is about 1 M. (auth)

15587 INFLUENCE OF SOLVENT AND TEMPERATURE UPON THE FLUORESCENCE OF INDOLE DERIVATIVES. Kirby, Edward P.; Steiner, Robert F. (Naval Medical Research Inst., Bethesda, Md.). J. Phys. Chem.; 74: 4480-90(24 Dec 1970).

The temperature dependence of fluorescence quantum yield for indole in water can be rationalized in terms of two nonradiative deexcitation processes. One of these is temperature independent and the other is temperature dependent. The temperature-dependent process may be associated with electron ejection from the excited indole. When D_2O is used as the solvent, or nonaqueous solvents are added to H_2O solutions, the magnitude of the temperature-dependent process is decreased. Indole derivatives which have a lower quantum yield than indole generally exhibit a decreased apparent activation energy, but this may be due to the introduction of a second, unresolved, temperature-dependent deexcitation process with a lower activation energy. (auth)

15588 SECONDARY DEUTERIUM ISOTOPE EFFECTS IN THE DIPHENYLKETENE-α-METHYLSTYRENE CYCLOADDITION. Snyder, Eugene I. (East Tennessee State Univ., Johnson City). J. Org. Chem.; 35: 4287-8(Dec 1970).

The isotope effects in competitive reactions of α-methylstyrene and α-methylstyrene-d_3 in diphenylketene cycloadditions were measured. The observed isotope effect points to a concerted reaction of ketene cycloadditions with a quite small charge accumulation. (D.P.O.)

15589 ACIDITY OF HYDROCARBONS. XXXIV. RATE OF PROTON ABSTRACTION FROM p-TRIFLUOROMETHYLTOLUENE BY LITHIUM CYCLOHEXYLAMIDE IN CYCLOHEXYLAMINE. Streitwieser, A. Jr.; Holtz, David (Univ. of California, Berkeley). J. Org. Chem.; 35: 4288-90(Dec 1970).

Competition experiments for proton abstraction from p-trifluoromethyltoluene (TFMT) and TFMT-α-d_3 by lithium cyclohexylamide (LiCHA) in cyclohexylamine (CHA) were studied. The reactivities were also compared to fluorobenzene-2-d(t) and triphenylmethane-d(t). The use of both TFMT and TFMT-α-d_3 permitted the determination of the hydrogen–deuterium isotope effect in the LiCHA–CHA system. (D.P.O.)

15590 ADDITION OF HYDROGEN HALIDE TO 1-ALKYNYLPHOSPHINES. KINETICS AND MECHANISM. Borkent, G.; Drenth, W. (Univ., Utrecht). Rec. Trav. Chim.; 89: 1057-67 (Oct 1970).

Addition of one molecule of hydrogen halide to the triple bond of 1-alkynylphosphines in aqueous solution is a trans reaction the rate of which is proportional to the activity of the halide ions. Rates of addition of HCl and DCl are approximately equal. The rate determining step involves addition of halide ion to protonated 1-alkynylphosphine. (auth)

15591 HIGH-RESOLUTION INFRARED SPECTRA OF NORMAL AND DEUTERATED METHANOL BETWEEN 400 cm^{-1} AND 1300 cm^{-1}. Woods, Douglas Richard. Ann Arbor, Mich.; Univ. of Michigan (1970). 114p. University Microfilms Order No. 70-21,819.

Thesis.

The high-frequency portion of the internal rotation infrared absorption spectrum was measured with a resolution of 0.07 cm^{-1} for CH_3OH, CD_3OH, CH_3OD, and CD_3OD vapor in the regions of 900–520 cm^{-1}, 780–520 cm^{-1}, 770–410 cm^{-1}, and 680–410 cm^{-1} respectively. The vibration rotation spectrum due to the CH_3OH CO stretch was measured along with the spectra due to the CO stretching and OH bending modes of CD_3OH, CH_3OD, and CD_3OD. The resolution was about 0.07 cm^{-1} for the stretching spectra, and 0.11 cm^{-1} for the bending spectra. The rotational fine structure of the parallel type CO stretching mode of CD_3OH and CH_3OD closely resembles that of a symmetric top, which is expected since the asymmetry is so slight. Transmission curves were calculated and plotted by a computer for different assumed changes in the barrier height. A good fit of the irregular spreading of the CH_3OH CO stretch was found with a 19 ± 2 cm^{-1} increase in the barrier height. For other vibrations, different changes in the barrier height are expected. A somewhat larger change in the barrier for the symmetric CH_3 stretch would account for the fact that the P and R branch lines are not readily apparent. It is felt that quite large changes in the barrier for the OH bend and the symmetric CH_3 bend may be the explanation for the lack of parallel type absorption bands in the CH_3OH spectrum assignable to these vibrations. (Diss. Abstr. Int., B)

15592 STUDIES OF ION-MOLECULE REACTION KINETICS BY ION CYCLOTRON RESONANCE TECHNIQUES. Buttrill, Sidney Eugene Jr. Stanford, Calif.; Stanford Univ. (1970). 224p. University Microfilms Order No. 70-18,383.

Thesis.

The theory of ion cyclotron resonance line shapes was developed for the case where the ions do not suffer any collisions with neutral gas molecules. Experimental and theoretical line shapes are in good agreement. Expressions were derived for the ion cyclotron single resonance signal intensities of both primary and secondary ions at low pressure and a procedure is described for obtaining ion-molecule reaction rate constants from single resonance spectra. Ion-molecule reaction rate constants obtained for the following reactions are: $CH_4^+ + CH_4 \rightarrow CH_5^+ + CH_3$, 9.5×10^{-10} cm^3/molecule sec; $CH_2D_2^+ + CH_2D_2 \rightarrow CH_3D_2^+ + CHD_2$, 5.1×10^{-10}; $CH_2D_2^+ + CH_3D_2 \rightarrow CH_2D_3^+ + CH_2D$, 4.1×10^{-10}; $C_2H_2^+ + C_2H_2 \rightarrow C_2H_3^+ + H_2$, 3.9×10^{-10}; and $C_2H_2^+ + C_2H_3 \rightarrow C_4H_3^+ + H$, 8.3×10^{-10}; these are in good agreement with rate constants obtained by other techniques. Ion cyclotron resonance spectroscopy is used to study the collision stabilization of ion-molecule reaction complexes in acetylene and ethylene. The stabilizing collisions in both compounds result in the formation of intermediates in which hydrogen rearrangement can occur leading to the exchange of hydrogens between the reaction complex and the stabilizing neutral. The specific reactions studied in acetylene were $C_4H_2^+ + C_2H_2 \rightarrow (C_6H_4^+)^* \xrightarrow{M} C_6H_4^+ + M^*$ and $C_4H_3^+ + C_2H_2 \rightarrow (C_6H_5^+)^* \xrightarrow{M} C_6H_5^+ + M^*$, where the stabilizing neutral M is acetylene. In a mixture of acetylene and acetylene-d_2, addition of acetylene-d_2 to either $C_4(H,D)_2^+$ or $C_4(H,D)_3^+$ is favored over addition of acetylene. Collision stabilization in the ethylene reactions was studied using 1,1-dideuterioethylene. The major cross products in a mixture of hydrogen sulfide and ehtylene at 12.5 eV ionizing electron energy are CH_2S^+ and CH_2SH^+. The hydrogen sulfide-ethylene reaction complex has an ethanethiol molecular ion structure. The reaction of hydrogen sulfide ion with acetylene produces HCS^+ and $C_2H_3S^+$. The reactions of hydrogen sulfide with acetylene-d_2 indicate that the reaction complex is best represented as the enol tautomer of thioacetaldehyde. Charge localization on sulfur in the reaction complex inhibits the extensive hydrogen rearrangement usually found in unsaturated hydrocarbon ion-molecule reactions. Double resonance studies of the proton and deuteron transfer reactions of deuterium labeled CH_5^+, $C_2H_5^+$, and $C_2H_3^+$ ions indicates that all of the hydrogens in these ions become equivalent through intramolecular rearrangements which have a rate greater than 10^4 sec^{-1}. The quasi-equilibrium theory of unimolecular reactions was applied to the calculation of ion-molecule reaction product distributions in ethylene and ethylene-acetylene mixtures. The unimolecular decomposition rates of the ion-molecule reaction complex were computed. When the reaction complex is formed from partially deuterated reactants, there is an isotope effect favoring loss of hydrogen over deuterium. The quasi-equilibrium theory calculations accurately predict this isotope effect. Because these calculations do not involve any adjustable parameters which significantly affect the calculated isotope effect, they are good evidence for the validity of the equilibrium hypothesis. (Diss. Abstr. Int., B)

15593 ISOTHERMAL COMPRESSIBILITY OF DEUTERIUM OXIDE AT VARIOUS TEMPERATURES. Millero, Frank J.; Lepple, Fred K. (Univ. of Miami, Fla.). J. Chem. Phys.; 54: 946-9(1 Feb 1971).

The isothermal compressibilities of deuterium oxide solutions were measured from 5 to 65°C. The measurements were made by a piezometric technique from 1 to 34 bar and extrapolated to 1 atm. The results are briefly discussed and compared to the values for normal water. (auth)

15594 MICROWAVE SPECTRUM, STRUCTURE, AND DIPOLE MOMENT OF CYCLOPROPYLPHOSPHINE. Dinsmore, Lee A.; Britt, Chester O.; Boggs, James E. (Univ. of Texas, Austin). J. Chem. Phys.; 54: 915-18(1 Feb 1971).

The microwave spectra of three isotopic species of cyclopropylphosphine were analyzed. The conformation of the molecule is the symmetric one allowing maximum interaction of the lone pair electrons of phosphorus with the intraannular orbitals of the cyclopropyl ring. A structure compatible with the observed

moments of inertia yielded, along with other parameters, a C–P bond distance of 1.834 Å, distinctly shorter than that observed in other organic phosphine derivatives. The dipole moment was found to be 1.16 D. (auth)

15595 STUDY OF IODINE EXTRACTION KINETICS BY MEANS OF THE ISOTOPE EXCHANGE METHOD. Iofa, B. Z.; Nesmeyanov, A. N.; Kireev, G. I. (Moscow State Univ.). Teor Osn. Khim. Tekhnol; 4: 429-32(May 1970). (In Russian).

The kinetics of iodine extraction by various solvents and the surface resistance in the $H_2O-I_2-KI-CCl_4$ system were studied. The rate of extraction and isotopic exchange of iodine in the $H_2O-I_2-KI-CCl_4$ system at 2 to 3°C did not reveal the surface resistance. It is shown that the rate of iodine extraction is limited by the diffusion (mass transfer), which is in agreement with published data. (R.V.J.)

15596 ISOTOPIC STUDIES OF THE PROTON–HYDROGEN MOLECULE REACTION. Holliday, M. G.; Muckerman, J. T.; Friedman, L. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys.; 54: 1058-72(1 Feb 1971).

The atomic-ion–molecule systems of protons or deuterons and isotopic hydrogen molecules were studied experimentally to provide data to be compared with recently reported classical trajectory calculations on an ab initio potential energy surface. Absolute cross sections (accurate to within an estimated error of ±20%) for the following atomic-ion exchange reactions $D^+ + H_2 \rightarrow HD + H^+$ (1), $H^+ + D_2 \rightarrow HD + D^+$ (2), and $D^+ + HD \rightarrow D_2 + H^+$ (3) were investigated in a tandem mass spectrometer system, with carefully calibrated geometry, as a function of collision energy. Endothermic charge-transfer processes $D^+ + H_2 \rightarrow HD^+ + H$ (4), $D^+ + D_2 \rightarrow D_2^+ + D$ (5), $D^+ + HD \rightarrow HD^+ + D$ (6), $\rightarrow D_2^+ + H$ (7), $H^+ + H_2 \rightarrow H_2^+ + H$ (8), $H^+ + D_2 \rightarrow HD^+ + D$ (9), $\rightarrow D_2^+ + H$ (10) were observed, and their cross sections were determined as a function of collision energy. Energy distributions of the ionic species participating in these reactions were measured by application of appropriate retarding fields. The experimental results for atomic-ion exchange reactions [(1) – (3)] are not easily compared with theoretical cross sections because the latter were calculated above energy thresholds for endothermic charge-transfer reactions [Reactions (4) – (10)]. These processes were not considered in the theoretical treatment, though our results show that, where energetically possible, they indeed dominate the reactive collisions. The extent of the observed endothermic charge transfer was unexpected, but can be rationalized by postulating that very efficient translational to internal energy conversion occurs, followed by radiationless transition to a weakly bound or repulsive excited electronic state of H_3^+. This $^1E'$ state has been identified by a simple Hückel calculation. Comparisons of energy distributions of product and reactant ions superficially indicate "complex formation" at relatively low collision energies and "direct reaction" at higher energies for atomic-ion exchange reactions [(1) – (3)]. The efficient transfer of kinetic to internal energy in the endothermic charge-transfer processes suggests complex formation mechanisms. This idea is further supported by isotopic abundance data. Although the energy distributions of atomic-ion exchange products above the endothermic charge-transfer threshold are consistent with a direct mechanism, it should be noted that the relative yield of atomic-ion products compared to molecular-ion products is small in this energy range. This is in no way inconsistent with trajectory studies and may indeed be present at lower energies where it would be effectively concealed. The absolute characterization of mechanism as "direct" or "complex formation" does not appear in the trajectory calculations nor is it suggested in our experiments. (auth)

15597 SULFUR ISOTOPE EFFECTS IN VOLCANIC GAS MIXTURES. Grinenko, V. A.; Thode, H. G. (McMaster Univ., Hamilton, Ont.). Can. J. Earth Sci.; 7: 1402-9(Dec 1970).

Sulfur isotope effects in the exchange systems (1) $H_2S \rightleftharpoons S^0$ and (2) $SO_2 \rightleftharpoons S^0$ were studied at various temperatures. It was shown that in the presence of water vapor sulfur isotope exchange proceeds at an appreciable rate in (1) above 150°C and in (2) above 300°C. The isotopic exchange constant for (1) approaches unity in the temperature range from 200 to 400°C° and the exchange constants for (2) at 400°C and 450°C equal 1.0095 and 1.0090 respectively favoring ^{34}S in the SO_2. The kinetic isotope effect in the chemical reduction of SO_2 to S^0 in consequence of its interaction with H_2S was determined at 25°C, 200°C, and 280°C. At these temperatures the $^{32}SO_2$ molecules react 1.6% faster than the $^{34}SO_2$ molecules. It is concluded that the spread in isotopic composition of various forms of sulfur in volcanic gases is caused not only by isotope exchange reactions between oxidized and reduced forms of sulfur but also by kinetic isotope effects in unidirectional reactions which result from major temperature changes at the outflow. (auth) (Canada)

15598 KINETICS OF THE EXCHANGE REACTION OF DIMETHYLARSENIC DEUTERIDE WITH DIETHYLARSINE. Cullen, W. R.; Leeder, W. R. (Univ. of British Columbia, Vancouver). Can. J. Chem.; 48: 3757-60(1 Dec 1970).

The exchange reaction $(CH_3)_2AsD + (C_2H_5)_2AsH \rightleftharpoons (CH_3)_2AsH + (C_2H_5)_2AsD$ can be monitored by conventional nuclear magnetic resonance spectroscopy. The equilibrium constant in diethyl ether-d_{10} solution was 1.2 ± 0.1 and the rate constant for the forward reaction was $4.95 \pm 0.25 \times 10^{-6}$ l mole^{-1} s^{-1} at 35°. Dimethylarsine exchanged rapidly with methanol-d_4 and bis(trifluoromethyl)arsinic deuteride. (auth) (Canada)

15599 ELECTRONIC STATES OF HEAVILY DOPED MOLECULAR CRYSTALS: NAPHTHALENE. II. EXPERIMENTAL. Hong, Hwei-kwan; Robinson, G. Wilse (California Inst. of Tech., Pasadena). J. Chem. Phys.; 54: 1369-84(1 Feb 1971).

The energy states and optical spectra of heavily doped mixed crystals are investigated. Studies are made for the following binary systems: (1) naphthalene-h_8 and -d_8, (2) naphthalene-h_8 and -αd_4, and (3) naphthalene-h_8 and -βd_4, corresponding to strong, medium, and weak perturbations, respectively. In addition to ordinary absorption spectra at 4°K, band-to-band transitions at both 4 and 77°K are also analyzed with emphasis on their relations to cooperative excitation and over-all density-of-states functions for mixed crystals. It is found that the theoretical calculations presented in a previous paper agree generally with experiments except for cluster states in system (1) at lower guest concentrations. These features are discussed semiquantitatively. As to the intermolecular interaction parameters, it is found that experimental results compare favorably with calculations based on experimental density-of-states functions but not with those based on octopole interactions or charge-transfer interactions. Previous experimental results of Sheka and the theoretical model of Broude and Rashba are also compared with present investigations. (auth)

15600 INFRARED SPECTRA OF THE ARGON MATRIX-ISOLATED CYANAMIDE, CYANAMIDE-d_2, AND CARBODIIMIDE. King, S. T.; Strope, J. H. (Dow Chemical Co., Midland, Mich.). J. Chem. Phys.; 54: 1289-95(1 Feb 1971).

The infrared spectra of cyanamide and cyanamide-d_2 isolated in solid argon at 20°K were studied. The NH_2 and ND_2 wagging frequencies were observed at 414 and 310 cm^{-1}, respectively, and were interpreted in terms of "inversion" transitions. Cyanamide and cyanamide-d_2 were also pyrolyzed in a hot nozzle under very low vapor pressure, and the carbodiimide produced from the pyrolysis was positively identified from the resulting infrared spectra. (auth)

15601 EXCITED SINGLET STATE RADIATIVE AND NONRADIATIVE TRANSITION PROBABILITIES FOR ACETONE, ACETONE-d_6, AND HEXAFLUOROACETONE IN THE GAS PHASE, IN SOLUTION, AND IN THE NEAT LIQUID. Halpern, Arthur M.; Ware, William R. (Univ. of Minnesota, Minneapolis). J. Chem. Phys.; 54: 1271-6(1 Feb 1971).

Fluorescence lifetime and fluorescence quantum yield measurements were made on acetone and acetone-d_6 in the gas phase, in solution, and in the neat liquid. The variation of the radiative and nonradiative transition probabilities with deuteration, and the effect of solvent environment are discussed. Radiative transition probabilities are compared with those calculated from the equation of Strickler and Berg. The discrepancies between the observed and calculated lifetimes are discussed in terms of vibronically induced transitions. (auth)

15602 MONTE CARLO CALCULATIONS OF ENERGY PARTITIONING AND ISOTOPE EFFECTS IN REACTIONS OF FLUORINE ATOMS WITH H_2, HD, AND D_2. Muckerman, J. T. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys.; 54: 1155-64 (1 Feb 1971).

A total of 16,000 three-dimensional classical trajectories on an optimized semiempirical potential energy surface were computed for collisions of F atoms with H_2, HD, and D_2. Analysis of the reactive trajectories indicates general agreement with results of infrared chemiluminescence and chemical laser studies with respect to the partitioning of the available energy among the translational, rotational, and vibrational degrees of freedom in the reaction products. Of particular interest is the calculated effect of reactant rotation on the reaction cross sections for all the isotropic systems, and on the intramolecular isotope effect in the reaction of F with HD. These phenomena have not as yet been seen experimentally. (auth)

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15603 PARAMAGNETIC RESONANCE ABSORPTION AND TRIPLET STATE ENERGY TRANSFER OF PHOTOEXCITED β-METHYLNAPHTHALENE MOLECULES IN NAPHTHALENE SINGLE CRYSTALS. Ashford, Nicholas A.; Hutchison, Clyde A. Jr. (Univ. of Chicago). J. Chem. Phys.; 54: 1165-77(1 Feb 1971).

The electron paramagnetic resonance absorption spectra of the triplet state species in the four guest-host crystal systems, β-methylnaphthalene-d_{10} in naphthalene-d_8, β-methylnaphthalene-d_{10} in naphthalene-h_8, β-methylnaphthalene-h_{10} in naphthalene-d_8, and β-methylnaphthalene-h_{10} in naphthalene-h_8, were investigated in the temperature range ~5 to ~25°K. Values of triplet state spin-Hamiltonian parameters were measured. Rates of triplet state signal decays after cessation of illumination were determined. The variations of triplet state signal intensities with temperature during constant continuous irradiation were studied. The results were interpreted in terms of a model of energy transfer processes in these crystals. Values of the parameters of the model for the cases of these systems were given. The triplet state species which is observed in the β-methylnaphthalene-d_{10} in naphthalene-h_8 system was shown to be a naphthalene host molecule, whereas in the other three systems the triplet state species is a guest β-methylnaphthalene molecule. (auth)

15604 KINEMATIC MODEL FOR REACTION. III. DETAILED DYNAMICS OF THE REACTION OF Ar^+ WITH D_2. George, Thomas F.; Suplinskas, Raymond J. (Yale Univ., New Haven). J. Chem. Phys.; 54: 1037-45(1 Feb 1971).

The kinematic model for the reaction was extended to the prediction of detailed dynamical properties of reaction: product angular and velocity distributions, differential reaction cross sections, and internal energy distributions. The dynamics of nonreactive scattering are also treated. The model is applied to the $Ar^+ + D_2 \rightarrow ArD^+ + D$ reaction for Ar^+ energies of 20, 50, and 75 eV. Good agreement with experiment is obtained. The results imply that in the relative energy range corresponding to several electron volts, the chemical process is dominated by the repulsive core interactions appropriately modified by elastic intermolecular potentials; simple mechanical considerations can characterize the process on this basis. Within the framework of the model, the forward peaking or "stripping" character of the differential reaction cross section is entirely dependent upon the attractive elastic intermolecular potential between receding products; a strongly backward peaked or "rebound" differential reaction cross section is obtained when this potential is not present. (auth)

15605 KINEMATIC MODEL FOR REACTION. IV. ORIENTATION AND ISOTOPE EFFECT IN THE Ar^+ + HD REACTION. George, Thomas F.; Suplinskas, Raymond J. (Yale Univ., New Haven). J. Chem. Phys.; 54: 1046-9(1 Feb 1971).

The kinematic model for reaction was used to evaluate the influence of molecular reorientation on the isotope effect in the reaction of Ar^+ with HD. Since the centers of mass and charge do not coincide in HD, there is a torque on the molecule during the approach of the ion which enhances the possibility of collision with the hydrogen end of the molecule. Calculations were performed both with and without this effect for Ar^+ lab energies in the range 10 to 70 eV. The results below 30 eV have no quantitative significance, but indicate that orientation could have a considerable effect. At higher energies, both calculations give quite reasonable predictions of the isotope effect; the orientation effect provides a noticeable but small difference in the results. The range of relative kinetic energies for which the predicted isotope effects are within experimental error is the same range in which the kinematic model provides relatively accurate predictions of product angular and velocity distributions. (auth)

15606 ISOTOPIC EXCHANGE KINETICS BETWEEN CHLOROMETHYL FORMATE AND CHLORIDE ION. Joerchel, Egon; Lanteime, Frederic; Chemla, Marius (Univ., Paris). J. Chim. Phys.; 67: 1807-11(Oct 1970). (In French).

The kinetics of the exchange of ^{36}Cl between lithium chloride and chloromethylformate in methyl ethyl ketone was studied in the temperature range −21°C to +22.5°C. The exchange was investigated by analyzing samples in the vapor phase. The reaction is of the second order. The observed decrease in the rate constant with increasing concentration of LiCl can be attributed to the incomplete dissociation of LiCl. Conductivity measurements led to the determination of the degree of dissociation α. It is shown that the bulk velocity results from two parallel elementary reactions: the exchange with the free ion Cl^- and that with LiCl association. The rate constant is presented by the equation: $k_2 = \alpha k_2' + (1-\alpha)k_2''$. At 0°C for the free ion Cl^-: $k_2' = 3.0 \pm 0.2$ 10^{-2} l mole^{-1} s^{-1}; for undissociated LiCl: $k_2'' = 9.7 \pm 1.5$ 10^{-4} l mole^{-1} s^{-1}. (France)

15607 KINETIC ISOTOPE EFFECTS AS GUIDES TO TRANSITION-STATE STRUCTURES IN DEPROTONATION REACTIONS. Bordwell, F. G.; Boyle, William J. Jr. (Northwestern Univ., Evanston, Ill.). J. Amer. Chem. Soc.; 93: 512-14(27 Jan 1971).

An investigation of kinetic isotope effects as guides to transition state structure in deprotonation reactions resulted in the conclusion that the hope, which at one time seemed bright, for a simple general correlation of Brønsted coefficients, kinetic isotope effects, and solvent isotope effects with the extent of proton transfer in the transition state has proved vain. Calculations of the solvent isotope effects for rates of neutralization of α-nitrotoluene ($PhCH_2NO_2$, $PhCHDNO_2$, and $PhCD_2NO_2$) in water at 25°C gave 1.14 and 1.18 for hydroxide ion (2 methods) and 1.2 for morpholine. Twenty-one additional points were obtained for the Bell–Goodall curve in the ΔpK −10.1 to +0.3 by measuring the rates of deprotonation and dedeuteration of the nitroalkanes with bases ranging in strength from hydroxide ion to pyridine. (D.H.M.)

15608 SOLID STATE INFRARED ABSORPTION SPECTRA OF DEUTERATED LONG CHAIN FATTY ACIDS AND ESTERS. Dinh-Nguyen, Nguyen; Fischmeister, Ingrid (Univ., Goteborg). Ark. Kem.; 32: 205-16(Oct 1970).

The spectra of some deuterated compounds were investigated between 4000 and 400 cm^{-1}. Perdeuteration of acids or esters causes the intensity of the band progression to decrease strongly. Partial geminal deuteration near the ester group disturbs the coupling between chain and ester group modes. An irregular band progression was noticed on vicinal dideuteration. (auth) (Sweden)

15609 SOLID STATE INFRARED ABSORPTION SPECTRA OF THE POSITIONALLY ISOMERIC METHYL GEM-DIDEUTERO-OCTADECANOATES. Dinh-Nguyen, Nguyen; Fischmeister, Ingrid (Univ., Goteborg). Ark. Kem.; 32: 181-203(Oct 1970).

The spectra of the isomeric geminally dideuterated methyl octadecanoates were investigated between 4000 and 400 cm^{-1} in potassium bromide pellets. They were found to be similar to the spectra of the homologous series of methyl alkanoates. This similarity is caused by disruption of the coupling of the methylene chain modes by the dideutero-methylene group. The chain part between ester group and deutero-methylene group absorbs strongly, the other chain part weakly. The coupling of the methylene rocking modes is likewise disrupted by the substituent. The spectra are characteristic for each isomer and can be used for identification. (auth) (Sweden)

15610 ACID-INDUCED AROMATIC HYDROGEN EXCHANGE. 10. DETERMINATION OF THE EXCHANGE RATES OF DEUTERIUM AND TRITIUM FOR PROTIUM IN BROMOBENZENE. KINETIC ISOTOPE EFFECT ON ISOTOPIC EXCHANGE. VARIATION OF THE KINETIC ISOTOPE EFFECT WITH THE ACID CONCENTRATION. Olsson, Stig (Univ., Stockholm). Ark. Kem.; 32: 105-10(Oct 1970).

The D–H and T–H exchange rate constants for the para position of bromobenzene were determined in aqueous H_2SO_4 in a heterogeneous system at 25.0 ± 0.1°C and those for the corresponding homogeneous system were calculated. The kinetic isotope effects on isotopic exchange were determined in 87.07 and 92.65 wt % H_2SO_4. It was found that the isotope effects were stronger than expected and that they varied with H_2SO_4 concentration. The partial rate factors for D–H and T–H exchange in 87.07 wt % H_2SO_4 were also determined. (auth) (Sweden)

15611 DIFFUSION OF IRON AND COBALT IN NICKEL SINGLE CRYSTALS. Heuer, Charles Frederick. Rolla, Mo.; Univ. of Missouri (1970). 52p. University Microfilms Order No. 70-21,248.

Thesis.

Diffusion coefficients of ^{59}Fe in Ni were determined in the temperature range 815 to 1200°C. The temperature dependence can be represented by an Arrhenius type relationship, $D_{Fe \rightarrow Ni} = 0.48 \exp(-62500/RT)$ cm^2/sec. The effect of the isotopic mass on the diffusion coefficient of Co in Ni was also investigated. The isotope effect parameter, E, was found to vary from 0.26 to 0.84 over the temperature range 970.5 to 1200°C. Both results are consistent with the single vacancy mechanism of diffusion. No evidence of divacancy contributions to the mass transport was found. (Diss. Abstr. Int., B)

15612 SOLVENT EFFECTS ON THE ENERGY OF THE PRINCIPAL ELECTRONIC TRANSITION OF p-NITROTOLUENE-α-d_3 AND p-METHYLANISOLE-α-d_3. Schubert, W. M.; Robins, Janis (Univ. of Washington, Seattle). J. Org. Chem.; 36: 239-40(15 Jan 1971).

An effort was made to find direct evidence for solvent enhancement of C–H hyperconjugation in the effect of a number of sol-

vents on the relative principal electronic transition energies of p-nitrotoluene and p-nitrotoluene-α-d_3 (the electron migration being in the long axis of the molecule and away from the substituent) and of p-methylanisole and p-methylanisole-α-d_3 (the electron migration being toward the substituent). The only trend discernible for p-nitrotoluene and p-nitrotoluene-α-d_3 was a slight increase in $\nu_{CD_3} - \nu_{CH_3}$ in highly acidic solvents, a trend that accompanies a large increase in $\nu_H - \nu_{CH_3}$, the excitation energy difference between nitrobenzene and p-nitrotoluene. A plot of $\nu_H - \nu_{CD_3}$ against $\nu_H - \nu_{CH_3}$ is linear. Results of the study of the solvent effect on the excitation energy of p-methylanisole-α-d_3 showed no solvent effect on $\nu_{CD_3} - \nu_{CH_3}$. (D.H.M.)

15613 RELATIVE CONVERSION OF 6,7-^{3}H-ESTRONE TO ^{3}H-15α-HYDROXYESTROGENS AND ^{3}H-7α-HYDROXYESTROGENS BY GLOMERELLA FUSARIOIDES. Frey, Michael J.; Jirku, Helmut, Levitz, Mortimer (New York Univ.). J. Label. Compounds; 6: 355-61(Oct-Dec 1970).

Mixtures of 6, 7-^{3}H-estrone and 16-^{14}C-estrone were fermented in media of Glomerella fusarioides. Conversions of each form of estrone to 15α-hydroxyestrone (15α-OHE_1) and 7α-hydroxyestrone (7α-CHE_1) and in one experiment to 15α-hydroxyestradiol (15α-OHE_2) and 7α-hydroxyestradiol (7α-OHE_2) were compared. The metabolities were separated and purified by repeated column chromatography on Celite. Similar to results reported for nonisotope studies, ^{14}C-estrone was converted to more 7α-hydroxyestrogens than 15α-hydroxyestrogens. The reverse was true for the tritiated substrate. The difference is attributed to an isotope effect resulting in diminished hydroxylation of the tritiated substrate at C-7 with concomitant enhanced hydroxylation at C-15 where no isotope effect would be expected. Reduction to 17β-hydroxyestrogens also occurred, but quantitative significance for this pathway was confined to the 15α-hydroxy compound. (auth)

15614 ISOTOPIC EXCHANGE REACTIONS BETWEEN CHLORIDE IONS AND SOME ORGANIC CHLORIDES. Elatrash, Ali M.; Nour, T. A. (Ain Shams Univ., Cairo). J. Chem. U.A.R.; 12: 155-64(1969).

The exchange of chloride ion between NaCl and benzyl chloride (C-I), p-nitrobenzyl chloride (C-II), 1-phenylethyl chloride (C-III), and 1-p-nitrophenylethyl chloride (C-IV) was studied in 90 wt % ethanol solutions at 35.0 and 50.0°C. The rate of exchange decreases in the order C-II > C-I > C-IV > C-III. In the case of C-I, the exchange process was found to proceed through a bimolecular mechanism with a value for the specific reaction rate, k, of $3.021 \pm 0.071 \times 10^{-5}$ 1 mole^{-1} sec.$^{-1}$ at 50.0°C. (auth)

15615 KETO-ENOL EQUILIBRIA IN 2,4-PENTANEDIONE AND 3,3-DIDEUTERIO-2,4-PENTANEDIONE. Thompson, David W.; Allred, A. L. (Northwestern Univ., Evanston, Ill.). J. Phys. Chem.; 75: 433-5(4 Feb 1971).

Isotope effects on intramolecular hydrogen bonds were investigated. Keto-enol equilibria were measured by NMR for pure 2,4-pentanedione and 3,3-dideuterio-2, 4-pentanedione and 0.5 mole fraction solutions in cyclohexane and by uv spectroscopy for dilute solutions in cyclohexane. (D.P.O.)

15616 EFFECTS OF DEUTERIUM SUBSTITUTION ON THE ELECTRON-TRANSFER REACTIONS. Chang, Raymond; Coombe, Robert (Williams Coll., Williamstown, Mass.). J. Phys. Chem.; 75: 447-8(4 Feb 1971).

A deuterium isotope effect on the rate of electron transfer for naphthalene and perdeuterionaphthalene, and the corresponding anion radicals was observed. The corresponding second-order rate constants were measured in both the slow and intermediate limit. (D.P.O.)

15617 SEMI-EMPIRICAL POTENTIAL ENERGY SURFACES FOR HYDROGEN-ATOM TRANSFER REACTIONS. Salomon, Mark (Electronics Research Center, Cambridge, Mass.). Int. J. Chem. Kinet.; 2: 175-84(May 1970).

A method for constructing potential energy surfaces previously proposed was extended to hydrogen transfer reactions between halide, oxygen, and carbon atoms. A qualitative relation was found between the repulsive energy and the number of anti-bonding electrons. In general, the calculated kinetic isotope effect is in satisfactory agreement with observed values and the contribution by H-atom tunneling to the rate of reaction is smaller than that obtained from other surfaces. (auth)

15618 SOLVENT-ISOTOPE EFFECT IN THE ENTHALPY OF SOME SOLUTES IN METHANOL. Krishnan, C. V.; Friedman, Harold L. (State Univ. of New York, Stony Brook). J. Phys. Chem.; 75: 388-91(4 Feb 1971).

The enthalpies of transfer to $CH_3OD(1)$ from $CH_3OH(1)$ at 25°C at infinite dilution were measured for several solutes and compared with available data for $D_2O \leftarrow H_2O$ transfers. The comparison serves to identify three solvation phenomena, which depend on the three-dimensional branched-chain hydrogen-bonded structure present in water but not in methanol: the markedly different hydration of alkyl and aryl groups, the "icebergs" or "hydration of the second kind" associated with the hydration of alkyl groups, and the "structure-breaking" effect in the hydration of Cs^+ and I^- ions. (auth)

15619 ACID-CATALYZED EXCHANGE OF HYDROGEN IN THIAMINE AND RELATED COMPOUNDS. Hutchinson, D. W. (Univ. of Warwick, Coventry, Eng.). Biochemistry; 10: 542-4 (2 Feb 1971).

The protons of the C(2')-methyl group of thiamine, oxythiamine, and imidazolethiamine undergo acid-catalyzed exchange in deuterium oxide. The position of exchange has been established by nuclear magnetic resonance studies on the sulfonic acids and 5-(2-hydroxyethyl)-4-methylthiazole produced by bisulfite cleavage of deuterated thiamine and oxythiamine. Confirmation of the position of exchange in thiamine and oxythiamine has been provided by mass spectrometry. A convenient method for the tritiation of thiamine has been developed. (auth)

15620 NITROGEN EQUILIBRATION REACTION $^{28}N_2 + {}^{30}N_2 = 2{}^{29}N_2$ OVER A WELL-REDUCED IRON SYNTHETIC AMMONIA CATALYST. Takezawa, N.; Toyoshima, I. (Hokkaido Univ., Sapporo). J. Catal.; 19: 271-6(Dec 1970).

The equilibrium reaction of nitrogen $^{28}N_2 + {}^{30}N_2 = 2{}^{29}N_2$ was studied over an iron synthetic ammonia catalyst, which was reduced by hydrogen with excessive precautions. It was found that the rate of the equilibrium reaction was proportional to one-half power of the partial pressure of nitrogen and the activation energy was 33 kcal/mole. Hydrogen was found to exert no influence upon the rate of the reaction above 400°C, whereas it accelerated the rate at 351°C. The results reported here were compared with those obtained by other authors and discussion is presented on the action of the promoter on the catalyst in connection with the states of adsorbed nitrogen. (auth)

15621 KINETICS AND ISOTOPE EFFECT OF AMMONIA SYNTHESIS OVER A SINGLY-PROMOTED IRON CATALYST. Aika, Ken-ichi; Ozaki, Atsumu (Tokyo Inst. of Tech.). J. Catal.; 19: 350-2(Dec 1970).

The kinetics and deuterium isotope effect of the ammonia synthesis reaction over a singly promoted iron catalyst were studied at 305°C under reduced pressures. The kinetic data as well as the isotope effect are essentially the same as those on the unpromoted iron previously reported. This result confirms that the potash promoter is more important in the mechanism of ammonia synthesis. (auth)

15622 CATALYSIS OF THE HYDROGEN/DEUTERIUM EQUILIBRATION REACTION BY NICKEL. Gasser, R. P. H.; Roberts, K.; Stevens, A. J. (Oxford Univ.). Surface Sci.; 20: 123-8(Mar 1970).

A clean nickel filament is an effective catalyst for the hydrogen isotope equilibration reaction at filament temperatures in the range 400 to 1000°K; at its maximum efficiency, about 12% of collisions lead to equilibration. The mechanism proposed for the reaction involves exchange between an atom adsorbed on the surface and a molecule in a physisorbed precursor state. (auth)

15623 MOLECULAR STABILITY AND THE $H_2 + D_2 \rightarrow 2HD$ FOUR-CENTER EXCHANGE REACTION SURFACE. Wilson, [Charles] Woodrow Jr. Pasadena, Calif.; California Inst. of Tech. (1970). 102p. University Microfilms Order No. 70-24,316. Thesis.

Partitions of the energy of the spin-coupling optimized GI wave functions of small systems were examined to isolate the factor responsible for chemical binding. One term, the contragradience energy, was found to dominate the binding energy in all cases. The magnitude of the contragradience energy is found to be insensitive to self-consistency effects; this property is used to extend the results to molecules too large for self-consistent calculation. Resonance, rotational barriers, and the concept of a bond region are discussed in terms of the contragradience energy. Calculations of the reaction surface for the $H_2 + D_2 \rightarrow 2HD$ four-center exchange reaction were examined in terms of the contragradience energy. (Diss. Abstr. Int. B)

Physical Chemistry

Refer also to abstracts 15645, 15719, 15722, 16410, 16458, 16590, 17090, 17302, and 17858.

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15624 (CEA-R-4125) STUDY OF THE PHYSICAL CHEMISTRY OF RUTHENIUM IN SEA WATER. Gueguenlat, Pierre (Commissariat a l'Energie Atomique, La Hague (France)). Dec 1970. 45p. (In French). Dep. NTIS (U. S. Sales Only).

Some aspects of the physical chemistry of ruthenium in seawater were studied using carrier-free nitrosyl ruthenium complexes as contaminating agents. Ruthenium was found in various forms; these forms were separated by the passage through a cationic resin: soluble forms (anionic, cationic, neutral, and organic), insoluble forms (several degrees of insolubility could be distinguished, especially in relation to the degree of polymerization), and forms in an intermediate state of solubility approaching that of the true insoluble state. The distribution of these forms is closely linked to the environmental purity, especially in seawater rich in suspended material, which acts as a carrier for the ruthenium and leads to the creation of new particle forms. The behavior of radioactive ruthenium wastes is liable to be affected by adsorption processes due to the formation of a precipitate when the waste comes in contact with seawater. (auth) (France)

15625 (ORNL-4622, pp 60-118) CHEMISTRY. (Oak Ridge National Lab., Tenn.).

From Molten-Salt Reactor Program.

Progress is reported on chemical research and development activities that are being conducted to establish the basic chemical information required for the development of advanced molten salt reactor systems. Subjects considered are: fission product behavior, properties of the alkali fluoroborates, physical chemistry of molten salts, chemistry of molten salt reactor fuel technology, and development and evaluation of analytical methods for molten salt reactors. (D.H.M.)

15626 (ORO-2124-23) PROPERTIES AND STRUCTURES OF SOLVATES OF METAL CHELATES ENCOUNTERED IN SOLVENT EXTRACTION SYSTEMS. Progress Report, January 1–December 31, 1970. Wagner, William F.; Sands, Donald E. (Kentucky Univ., Lexington. Dept. of Chemistry). Contract AT(40-1)-2124. 8p. Dep. NTIS.

Work was continued on the determination of the structure of the methanol solvate of erbium trisacetylacetonate, $Er(C_5H_7O_2)_3$: 2 CH_3OH. Coordinates for the erbium atoms have been established. The structure of the salts of lanthanum hexafluoroacetylacetonate, $NH_4La(C_5F_6HO_2)_4 \cdot H_2O$ and $CsLa(C_5F_6HO_2)_4 \cdot H_2O$ was also studied. Studies were initiated on crystals of $Nd(BFA)_3 \cdot 2\ H_2O$, where HBFA is the chelating agent $CF_3COCH_2COC_6H_5$. (J.G.B.)

15627 (RFP-1544) COMPUTER PROGRAMS TO DETERMINE CHEMICAL DIFFUSIVITIES USING THE BOLTZMAN–MATANO ANALYSIS. Doyle, Joe H. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 20 Jan 1971. Contract AT(29-1)-1106. 13p. Dep. NTIS.

A BASIC language computer technique was developed to determine chemical diffusivities, using the Boltzman–Matano analysis. The computer programs with printout examples and a sample run are discussed in detail. Data obtained in a study to be published later (RFP-1546, Harvey) on the determination of chemical diffusivity of plutonium–gallium alloys in the epsilon phase were used to demonstrate the program. (auth)

15628 STUDY OF URANIVANADATES IN AQUEOUS SOLUTION. Nicole, Jacques (Ecole Nationale Superieure de Chimie, Lille). Rev. Chim. Miner.; 7: 875-95(1970). (In French).

The results obtained by potentiometry and conductometry from the interaction between uranyl ions and vanadate solutions indicate the existence of a uranium–vanadium compound $H[UO_2(OH)_2VO_3]$ from which all the other compounds are derived. The formation of this compound is not always quantitative as it depends on the uranyl salt used. Uranimetavanadic acid forms quantitatively with uranyl acetate; more condensed compounds are formed as a result of the substitution of OH^- by VO_3^-. The formation of this acid occurs only as a transitory stage with uranyl perchlorate; the acid being decomposed by the H^+ formed during the reaction and giving uranitrimetavanadic acid $H[UO_2(VO_3)_3]$. (France)

15629 ELECTROCHEMICAL DETERMINATION OF THE FREE ENERGY OF FORMATION OF TANTALUM OXIDE. Barbi, Giovanni B. (EURATOM–CCR, Ispra, Italy). Z. Naturforsch.; 25a: 1515-16(Oct 1970).

Emf measurements were made at 1080 to 1276°K on the all-solid galvanic chain cell: $Pt/Ta + Ta_2O_5/ThO_2$ (+ 15 mole % La_2O_3)/ $Fe + FeO/Pt$. The results follow the equation: E(mV) = 723.6 – 0.1087 T (°K). The standard free energy of formation was found to be $\Delta G^0_{f,Ta_2O_5}/5 = -96.62 + 20.57 \times 10^{-3}$ T kcal/atom of oxygen. (D.L.C.)

15630 ELECTROCHEMISTRY OF NITRIC OXIDE AND OF NITROUS ACID AT A MERCURY ELECTRODE IN AQUEOUS SOLUTIONS. ELECTROCHEMISTRY AND HYDROLYSIS KINETICS OF THE 2,2'-BIPYRIDINE COMPLEXES OF IRON(III) AND IRON(II); ELECTROCHEMICAL KINETIC PARAMETERS FOR SEVERAL IRON COMPLEXES. PROTON NUCLEAR MAGNETIC RESONANCE STUDIES OF URANIUM(IV)–ETHYLENEDIAMINETETRAACETIC ACID COMPLEXES IN AQUEOUS (D_2O) SOLUTIONS. Ehman, Dewayne Lee. Riverside, Calif.; Univ. of California (1969). 139p. University Microfilms Order No. 70-19,235. Thesis.

The electrochemical reductions of nitric oxide and of nitrous acid at a mercury electrode were studied using chronopotentiometry, linear-sweep voltammetry, and controlled potential coulometry. Gaseous products from controlled potential coulometry were analyzed by gas chromatography. Nitric oxide is reduced in an overall one-electron process to nitrous oxide; nitrous acid is reduced in an overall four-electron process to hydroxylamine, which reacts with nitrous acid to produce nitrous oxide. Kinetic parameters have been determined, and reduction mechanisms have been proposed. The electrochemical behavior of three iron complexes with 2,2-bipyridine (bipy) was studied. A plausible mechanism for the electrochemical reduction of oxo-bridged $Fe_2(bipy)_4O(H_2O)_2^{4+}$ at Pt and at Au electrodes has been established using chronopotentiometry, triangular-wave voltammetry, and controlled potential electrolysis. The reduction product is monomeric $Fe(bipy)_3^{2+}$. Chronopotentiometry has been used to follow the hydrolysis of monomeric $Fe(bipy)_3^{2+}$ to the oxo-bridged dimer and to determine the rate law and a reasonable mechanism for this reaction. The hydrolysis is first order in monomer and first order in any base, which is present. The proposed mechanism involves attack by base to produce a seven-coordinate Fe(III) species. Fast-scan triangular-wave cyclic voltammetry (up to 300 V/sec) has been used to determine the rate of electron transfer for several monomeric iron complexes. Proton nuclear magnetic resonance spectra of 1:1 U(IV)EDTA complexes in 1.0 F Na_2SO_4 solutions have been obtained at 100 and at 60 MHz from pH −0.50 to pH 6.50 and from −6° to 108°C. The NMR spectra of these paramagnetic complexes exhibit contact shifts on the order of 20 ppM. The high temperature (>45°C) spectra between pH 1.00 and 3.00 exhibit an AX pattern and an upfield singlet with a relative intensity ratio of 2:1. Below pH 1.00 the resonances are broadened by ligand exchange. Above pH 3.00 large displacements in the chemical shift values of all EDTA proton resonances are observed, indicating the formation of a different U(IV)EDTA complex. At temperatures below 45°C the EDTA resonances broaden because of decreases in rates for the exchange processes. Below 7°C the A peak and the upfield singlet each split into two broad singlets; these splittings are shown to be caused by a decrease in the interconversions of the A methylenic protons and of the ethylenic protons. Cubic solution structures, which are consistent with the NMR data, magnetic susceptibility measurements, and results of acid-base titrations, have been proposed for the complexes in 1.0 F Na_2SO_4. The composition of the complex from pH 1.00 to pH 3.00 is U(IV)(EDTA)$(H_2O)(SO_4)^{2-}$. The rate constants and the activation parameters for the two EDTA proton interconversions have been determined by using computer analysis of the NMR line shapes. (Diss. Abstr. Int., B)

15631 SPECTROPHOTOMETRIC STUDY OF INTERACTION OF THE RARE EARTHS WITH ARSENAZO III AND COMPLEXONE III. Spitsyn, P. K.; Shvarev, V. S.; Popyvanova, T. P. (Gorky State Univ., USSR). Zh. Anal. Khim.; 26: 86-90(Jan 1971). (In Russian).

The behavior of the Arsenazo III complexes of the rare earths in the presence of Complexone III has been studied spectrophotometrically. It has been found that in this case the properties of the rare earth arsenazates are essentially different as compared with those in the absence of Complexone III. The addition of Complexone III permits complete masking of certain rare earths. (auth)

15632 COMPLEX FORMATION OF ZIRCONIUM AND THORIUM IONS WITH ARSENAZO III IN PERCHLORIC ACID SOLUTIONS. Muk, A.; Savvin, S. B. (Boris Kidric Inst. of Nuclear Studies, Belgrade. Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 26: 98-103(Jan 1971). (In Russian).

The complex formation of Th and Zr with Arsenazo III in perchloric acid solutions has been studied. The composition of the complexes depends on the ratio of the reagent and the metal in the solution, and does not depend on its acidity. The Me:R ratio is 1:2 with the reagent excess; 1:1 with the metal excess. The increase in the complex absorption in more acid media as compared with less acid is connected with the existence of two types of complexes of similar composition but, probably, of different structure. The conversion of the less intensely colored complex into a more intensely colored one with an increase in the $HClO_4$ con-

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centration is accompanied by the absorption of one or more protons. This optical effect is explained by the change in the nature of the bonds between ions of the complex-forming metal and separate functional groups of the reagent. At low acidity the nature of the bonds is similar to that of the hydrolyzed $Me(OH)_n^{(4-n)+}$ ion with ligands, in strongly acid media—to those of the Zr^{4+} ion. (auth)

15633 MEASUREMENT OF PRESSURE OF SATURATED VAPOR OF NEPTUNIUM TETRAFLUORIDE. Chudinov, E. G.; Choporov, D. Ya. Radiokhimiya; 12: 525-7(1970). (In Russian).

The saturated vapor pressure of neptunium tetrafluoride was measured by a differential variation of the effusion method in the interval 603 to 818.5°C. The data of two series of measurements (ten points) are described by the equation

$$\lg p_{mm\ Hg} = \frac{-15{,}680 \pm 85}{T} + 12.82 \pm 0.08$$

(the confidence intervals were calculated on the basis of 95% probability). The expression for the free energy of sublimation in the case of a change in the heat capacity $\Delta C_p = -6$ cal/deg. mole takes the form $\Delta G = 77{,}700 + 6T \ln T - 93.6T$. (auth)

15634 ACTIVITY COEFFICIENTS OF URANYL NITRATE IN AQUEOUS SOLUTION AT 10 TO 50°C. Komarov, E. V.; Pushlenkov, M. F.; Shpunt, L. B. Radiokhimiya; 12: 523-5(1970). (In Russian).

The activity coefficients were measured by the extraction method in which equilibrium concentrations of uranium were measured in the aqueous and organic (TBP) phases. (M.C.G.)

15635 CRYSTAL STRUCTURES OF AMERICIUM TRICHLORIDE HEXAHYDRATE AND BERKELIUM TRICHLORIDE HEXAHYDRATE. Burns, John H.; Peterson, J. R. (Oak Ridge National Lab., Tenn.). Inorg. Chem.; 10: 147-51(Jan 1971).

The structure of $AmCl_3 \cdot 6H_2O$ was studied by single-crystal x-ray diffraction methods. Some 1468 observations were used in a least-squares refinement of the 46 parameters which describe the structure with anisotropic temperature factors. Starting values for the parameters were obtained from the known structure of $GdCl_3 \cdot 6H_2O$ and the final values yielded an agreement index of 0.039. The structure consists of $AmCl_2(OH_2)_6^+$ cations and Cl^- anions joined by a network of hydrogen bonds, the existence of which are inferred from the Cl···O···Cl distances and angles found. The monoclinic unit cell of $AmCl_3 \cdot 6H_2O$ has the dimensions a = 9.702 (1) Å, b = 6.567 (1) Å, c = 8.009 (1) Å, and $\beta = 93°\ 37\ (1)'$; the space group is P2/n. X-ray diffraction by a powder sample of $BkCl_3 \cdot 6H_2O$ showed that it is isostructural, and the following unit cell was derived: a = 9.66 (1) Å, b = 6.54 (1) Å, c = 7.97 (1) Å, and $\beta = 93°\ 46\ (5)'$. Unit-cell data are presented for the trichloride heptahydrates of La, Ce, and Pr. (auth)

15636 CRYSTAL AND MOLECULAR STRUCTURE OF TETRANITRATOBIS(TRIPHENYLPHOSPHINE OXIDE)CERIUM(IV). Mazhar-Ul-Haque; Caughlan, C. N.; Hart, F. A.; VanNice, R. (Montana State Univ., Bozeman). Inorg. Chem.; 10: 115-22(Jan 1971).

The crystal and molecular structure of the new complex tetranitratobis(triphenylphosphine oxide)cerium(IV) $[Ce(NO_3)_4\{OP(C_6H_5)_3\}]$ was determined by single-crystal x-ray diffraction techniques. The crystals are monoclinic, space group $P2_1/n$, with unit cell dimensions a = 13.908 (8), b = 17.589 (9), c = 16.476 (6) Å, and $\beta = 91.10\ (4)°$, and four molecules per unit cell. The data were collected on a diffractometer. The structure was solved by the heavy-atom technique. Positional and anisotropic thermal parameters have been refined by block-diagonal least-squares methods to a final R value, for 2868 observed reflections, of 0.047. Cerium is ten-coordinated to four bidentate nitrate groups and two oxygen atoms from triphenylphosphine oxide. The bond distances and angles are discussed. The isostructural thorium compound $Th(NO_3)_4\{OP(C_6H_5)_3\}_2$ is also described. (auth)

15637 X-RAY STUDIES OF CESIUM PENTACHLORODIURANYLATE. Bevz, A. S.; Kapshykov, I. I.; Vorobei, M. P.; Skiba, O. V. (Research Inst. of Nuclear Reactors, Melekess, USSR). Zh. Strukt. Khim.; 11: 936(Sep-Oct 1970). (In Russian).

Previous studies of the system $CsCl-UO_2Cl_2$ revealed two stable chemical compounds, $Cs_2UO_2Cl_4$ and $Cs(UO_2)_2Cl_5$. The structure of the first compound was studied by D. Hall et al. (Acta Crystallog. 20, 160, 1966). An attempt was made to determine the structure of the second compound, which was synthesized in a sealed thick quartz ampule using melted $Cs_2UO_2Cl_4$ and UO_2Cl_2 in the molar ratio ~1:3 with a small excess (~5 wt %) of uranyl chloride. The light yellow hygroscopic transparent crystals obtained had a density of 4.715 g/cm³. X-ray structural analysis was made of the needlelike monocrystals (0.2 to 0.3 mm cross section and 0.5 to 0.8 mm long) placed in glass capillaries with 15- to 20-μ-thick walls. The studies are being continued. (R.V.J.)

15638 COMPLEXES OF PEROXY RADICAL WITH TRANSITION METAL IONS. Samuni, A.; Czapski, Gideon (Hebrew Univ., Jerusalem). (Contract AT(30-1)-3753. J. Phys. Chem.; 74: 4592-4(24 Dec 1970).

A study of the transients formed on mixing peroxy radicals with solutions of transition metal ions was carried out using ESR spectroscopy. The role of H_2O_2 was discussed. An exchange reaction between a peroxy-metal transient and another metal ion was also observed. (D.P.O.)

15639 CONCERNING RHENIUM NITROGEN FLUORIDE AND TECHNETIUM NITROGEN FLUORIDE. Cowie, M.; Lock, C. J. L.; Ozog, J. (McMaster Univ., Hamilton). Can. J. Chem.; 48: 3760-3(1 Dec 1970).

The previously reported x-ray powder pattern of "ReNF" was found to be that of NH_4ReO_4 and it is suggested that the x-ray powder pattern of "TcNF" is that of $(NH_4)_2TcF_6$. In light of these results it is suggested that the existence of the discrete phases ReNF and TcNF has not been proven. (auth) (Canada)

15640 CRYSTAL STRUCTURE OF THE TETRAHYDRATED NICKEL URANYL VANADATE $Ni(UO_2)_2(VO_4)_2.4H_2O$. Borene, Jacques; Cesbron, Fabien (Univ., Paris). Bull. Soc. Fr. Miner. Crist.; 93: 426-32(Jul-Aug 1970). (In French).

The crystal structure of $Ni(UO_2)_2(VO_4)_2 \cdot 4H_2O$ was established using three-dimensional x-ray diffraction data obtained with an automatic diffractometer. The space group is Pnam. The final R factor is 0.069 with anisotropic thermal parameters for the cations and isotropic factors for the oxygen atoms. The crystal is built up by $[(UO_2)_2V_2O_8]_n^{2n-}$ slabs parallel to the (001) plane containing the symmetry centers. Nickel atoms and the four water molecules linked to them lie in the mirror plane. The octahedron of oxygen around nickel is completed by oxygens from uranyl group symmetrically related by the mirror plane. (France)

15641 STUDY OF THE PROTACTINIUM(V) PHOSPHATES. Le Cloarec, M. F.; Kovacevic, S.; Muxart, R. (Paris Univ., Arcueil, France). Rev. Chim. Miner.; 7: 735-45(1970). (In French).

The behavior of amorphous protactinium(V) orthophosphate was investigated by thermogravimetry, radiocrystallography, and infrared spectroscopy. The first results show the existence of two main crystalline phases; one of them present in the product heated to 800°C, the other one in the product heated to 1,050°C. The infrared spectrum of the orthophosphate is consistent with an orthophosphate structure. The spectrum of the product obtained at 1,050°C shows absorption regions characteristic of polyphosphate groups and is closely related to pyrophosphate spectra. The pyrophosphate ions however could not be identified by chromatography. (auth) (France)

15642 NEUTRON DIFFRACTION STUDY OF URANYL NITRATE DIHYDRATE. Dalley, N. Kent; Mueller, M. H.; Simonsen, S. H. (Univ. of Texas, Austin). Inorg. Chem.; 10: 323-8(Feb 1971).

The crystal structure of uranyl nitrate dihydrate, $UO_2(H_2O)_2(NO_3)_2$, has been determined by neutron diffraction. The structure is monoclinic with a = 14.124 (13), b = 8.432 (8), c = 7.028 (7) Å, $\beta = 108.0\ (1)°$, and space group $P2_1/c$ with 4 formula weights per unit cell. This is in disagreement with a previously reported x-ray study. In the present study the structure was solved with three-dimensional data by applying Patterson and Fourier techniques. The four uranium atoms per unit cell are located on special positions (a) and (b) of the space group. Each uranyl group is surrounded by a nearly perpendicular planar oxygen hexagon. This hexagon consists of two oxygen atoms from each of two equivalent bidentate nitrate groups and two oxygen atoms from equivalent water molecules. This arrangement is similar to that reported for the uranyl nitrate hexahydrate. The structural units are bound together by hydrogen bonds from the oxygen of the water molecule to the uncoordinated oxygen atom of the nitrate group and to the oxygen atom of the uranyl group. (auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 15562, 15718, 15755, 15962, 15964, and 17642.

15643 PROPERTIES AND NATURE OF THE STABILIZED ELECTRON. Ekstrom, A. (Univ. of Wisconsin, Madison).

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Contract AT(11-1)-1715. Radiat. Res. Rev.: 2: 381-409(Nov 1970).

The properties of stabilized electrons have been studied in a variety of environments, and these results provide the means for a critical test of the current theories of electron stabilization. Correlations between various properties of the electrons and the dielectric constants of the stabilizing environment have been emphasized in this review. These correlations include studies in both polar and nonpolar media. The survey of these studies indicated that the stabilization of electrons in polar media is independent of the dipolar relaxation times. This indication is substantiated by spectral measurements in both liquid and solid phases. 141 references have been surveyed for this summary. (B.L.M.)

Radiation Effects

Refer also to abstracts 16042 and 16458.

15644 EFFECTS OF RADIATION ON THE THERMAL DECOMPOSITION INDUCTION PERIOD IN AMMONIUM PERCHLORATE AND OTHER PSEUDOSTABLE MATERIALS. Levy, P. W. (Brookhaven National Lab., Upton, N. Y.); Herley, P. J. J. Phys. Chem.: 75: 191-201(21 Jan 1971).

The induction period of ammonium perchlorate, and other pseudostable inorganic solids, is shortened by exposure to radiation prior to isothermal decomposition. Specifically, the induction period, I, is related to the prior dose Φ, by the equation $I = C_1 - C_2 \log \Phi$, where C_1 and C_2 are constants. This relation applies to many materials over dose ranges between two and four orders of magnitude. To relate it to both the thermal decomposition kinetics and the radioinduced processes, induction period vs total dose equations were derived for a variety of different conditions. The equations can be derived without specifying the exact nature of the thermal or radioinduced mechanisms. It is assumed that these mechanisms are functions of a parameter that increases from a small initial value to a considerably larger limiting value. This unspecified parameter could refer to numerous physical quantities, e.g., average size or concentration of decomposition nuclei, crack length, bubble volume, etc., or to any of a large number of other more abstract variables. These considerations lead to 11 different induction period vs total dose equations. Only one of these, the equation for exponential growth during heating and linear growth during irradiation, corresponds to the experimentally observed relation. The fact that 11, out of a possible 12, different equations are obtained forms the basis for a new method of determining both the thermal and radioinduced induction period kinetics. (auth)

15645 STUDIES OF VAPORIZATION MECHANISMS AT ELEVATED TEMPERATURES. Rosenblatt, Gerd M. (Pennsylvania State Univ., University Park). pp 209-29 of Heterogeneous Kinetics at Elevated Temperatures. /Belton, G. R. (ed.). New York; Plenum Press (1970).

From International Conference on Heterogeneous Kinetics at Elevated Temperatures, Philadelphia, Pa. See CONF-690927.

The retarded vaporization of substances with small vaporization coefficients is a kinetic process of practical and theoretical interest at elevated temperatures. Studies of the retarded vaporization of As_4 and Sb_4 from (111) cleavage faces of arsenic and antimony single crystals have shown that initially slow, increasing vaporization rates coincide with the time required for thermal etch pits on the surface to intersect. Following the kinetic induction period, vaporization proceeds at a steady-state rate. Kinetic and microscopic results are in accord with the vaporization mechanism for arsenic and antimony in which the rate-limiting step occurs on a ledge of molecular dimensions (presumably at a kink site) and is associated with atomic rearrangement to form a tetrahedral vapor molecule. Retarded vaporization rates can be modified under some conditions; the steady-state vaporization rate of arsenic, but not of antimony, increases after exposure to 10^{-4} – 10^{-6} torr 0_2 or bombardment with fast neutrons. The vaporization coefficient of arsenic, 7×10^{-5} at 550°K, is much smaller than that of antimony, 0.2 at 650°K. This can be rationalized as reflecting differences in equilibrium enthalpies of vaporization and in atomization energies of the gaseous tetramers. (auth)

15646 UNSTABLE INTERMEDIATES. PART LXXIX. ELECTRON SPIN RESONANCE STUDIES OF THE EFFECT OF ENVIRONMENT UPON THE HYPERFINE PARAMETERS FOR CO_2^- AND NO_2. Sharp, J. H.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 18, 3075-80(1970).

Exposure of alkali and alkaline earth metal formates to ^{60}Co γ irradiation gave ESR spectra characteristic of CO_2^- radicals. These results are compared with those for CO_2^- in various matrices and with a range of results for NO_2 in different environments. Both radicals rotate or librate extensively, but after these movements have been quenched or allowed for, the effect of the environment upon the spin-density distributions and 2p/2s could be gauged. The results for CO_2^- were markedly dependent upon the nature of the host lattice, but those for the isoelectronic NO_2 radical were almost independent of environment. This difference is presumed to be a result of the negative charge of the former radical and of the consequent large crystal fields that it experiences. The ESR spectra of γ-irradiated alkali metal formates exhibit well resolved hyperfine coupling to the cation nuclei. Trends in the spin-densities derived therefrom are discussed. (auth) (UK)

15647 THE EFFECT OF γ-IRRADIATION ON THE MOESSBAUER LINE WIDTHS IN TRIS(ACETYLACETONATO)IRON(III). Bancroft, G. M.; Dharmawardena, K. G.; Stone, A. J. (Cambridge Univ., Eng.). J. Chem. Soc., D; No. 1, 6-7(6 Jan 1971).

The very large (ca 2 mm s^{-1}) line widths in the Mössbauer spectra of $Fe(acac)_3$ were reduced to ca 0.6 mm s^{-1} by γ irradiation. The reasons for such large decreases in line width are rationalized. (auth) (UK)

15648 COMPARISON OF THE EFFECTS AT LOW AND HIGH LET OF IONIC SCAVENGERS IN CYCLOHEXANE UNDER IRRADIATION. Burns, W. G.; Reed, C. R. V. (Atomic Energy Research Establishment, Harwell, Eng.). pp 61-75 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The yields of nitrogen from solutions of nitrous oxide in cyclohexane at varying $[N_2O]$ are compared for γ-radiation and for 2.1 MeV ^4He ions; a similar comparison is made for the yield of HD from solutions of perdeuteroammonia. Nitrous oxide and perdeuteroammonia were chosen as typical scavengers for negative and positive ions respectively; the decrease in $G(H_2)$ and G(HD) measure the respective yields of ions scavenged. The effects of such scavengers in γ-irradiation has previously been interpreted in terms of the distribution in separation of initially-formed positive ions and electrons, and the probability of their reaction with scavenger during their subsequent mutual approach. This interpretation is extended to the effects of dilute scavenger solutions on heavy particle tracks by assuming that the core of numerous low-energy events is dense enough to lead to unscavengeable neutralisation, leaving more widely-spaced high-energy events which are treated similarly to the γ-ray case. The experimental variation with scavenger concentration of G (scavenged ions) at high LET is greater than that predicted on this basis, and a better correlation was obtained using a treatment of diffusion and reaction which treats the whole track collectively. (auth) (UK)

Radiation Processes

15649 RADIATION-INDUCED POLYMERIZATION OF 3,3,4,4,5,5,5-HEPTAFLUOROPENTENE-1 AT HIGH PRESSURE. Brown, Daniel W.; Lowry, Robert E.; Wall, Leo A. (National Bureau of Standards, Washington, D. C.). J. Polym. Sci., Part A-1; 8: 3483-93(Dec 1970).

The γ-radioinduced polymerization of 3,3,4,4,5,5,5-heptafluoro-1-pentene under pressure was studied. Polymerization rates increase with pressure (activation volume equals −11 cc/mole) and temperature (activation enthalpy equals 6.5 kcal/mole) in liquid phase. At 13,800 atm and 25°C freezing occurs; the polymerization rate in the solid is very small. In liquid phase polymerization can continue for many hours after the irradiation is terminated. An active species is formed by radiation which initiates polymerization in the dark period. (auth)

15650 RADIATION-INDUCED CHAIN ISOMERIZATION OF cis-1,2-DIPHENYLPROPENE IN CYCLOHEXANE. Penner, Thomas L.; Hammond, George S. (California Inst. of Tech., Pasadena). J. Phys. Chem.; 75: 292-4(21 Jan 1971).

The isomerization behavior of cis-1,2-diphenylpropene in cyclohexane was studied at high concentration and low radiation dose. The initial G values were high enough to clearly demand a chain mechanism. However, the effect was quickly attenuated and became negligible at doses commonly used in γ irradiation experiments. At low doses the actual yield of trans-1,2-diphenylpropene remained essentially invariant within a given irradiation set and increased slowly at higher doses. This indicated that the chain isomerization is effectively inhibited by some material produced by irradiation. It was concluded that the chain process is effected through 1,2-diphenylpropene cations. (M.C.G.)

15651 BEITRAEGE ZUR KONSERVIERUNG VON HOLZ UND PAPIER. DIE FRAGE DES EINSATZES IONISIERENDER STRAHLEN ZUR SANIERUNG ALTER HOELZER UND PAPIERE. (Report on Conservation of Wood and Paper. The Question of the Use of Ionizing Radiation for the Sanitation of Old Woods and Papers). Beck, Walther; Gesswagner, Doris; Kaindl, Karl. Vienna; Hermann Boehlaus Nachf. (1969). 36p. DM 7,-.

The use of ionizing radiation to kill wood-destroying insects, mushrooms, and mold fungus is discussed. Changing paper and wood characteristics by γ irradiation is described along with the possible use of ionizing radiation for conservation of inorganic and organic materials in monument maintenance work. (M.C.G.)

15652 GRAFT POLYMERIZATION OF 1,1-DIHYDROPERFLUOROBUTYL ACRYLATE ONTO CELLULOSE FABRIC. Watanabe, Haruhiko; Chiba, Akira; Tuchida, Toshio; Kobayashi, Yoshio (Katata Research Inst., Otsu, Japan). J. Appl. Polym. Sci.; 14: 2731-7(Nov 1970).

1,1-Dihydroperfluorobutyl acrylate was prepared and grafted onto cellulose fabric by means of γ preirradiation to produce oil and water repellency. A 2% grafting was sufficient to impart oil and water repellency to cellulose fabric. In the case of 19.1% or 29.4% grafted fabrics, the grafting decreased rapidly with laundering, and the laundered fabric which possessed no oil and water repellency still had about 10% grafting of the perfluoro compound. Thus, the apparent graft polymerization takes place both on the surface and in the inner structure of the cellulose fiber; the polymer grafted onto the surface imparts oil and water repellency and is easily removed by laundering, whereas the polymer grafted onto the inner structure is hardly eliminated but does not impart oil and water repellency to the fabric. (auth)

15653 RADIATION STERILIZED, THIODIPROPIONIC ACID ESTER STABILIZED, PROPYLENE POLYMERS. Kelley, Joseph M.; Marinaccio, Paul J. (to Dart Industries Inc.). U. S. Patent 3,537,967. 3 Nov 1970. Filed 29 Jul 1966.

A process is described for the manufacture of a sterilized, heat-stabilized propylene polymer having a crystalline content of at least 40% and having good resistance to discoloration. An ester of thiodipropionic acid containing from 4 to 50 carbon atoms is added to the crystallized polymer, and the mixture is irradiated at a dose of at least 2.5 MRad of γ radiation. (B.L.M.)

15654 NATURE OF THE PARAMAGNETIC CENTRES AND THEIR PHOTOCHEMICAL CONVERSIONS IN THE MONOCRYSTAL OF L-TYROSINE HYDROCHLORIDE IRRADIATED AT 77°K. Pasoyan, V. G.; Pulatova, M. K.; Kayushin, L. P. (Inst. of Agrochemical Problems and Hydroponics, Erevan. Inst. of Biological Physics, Pushchino, USSR). Biophysics (USSR) (Engl. Transl.); 15: 8-16(1970).

Translated from Biofizika; 15: 12-19(1970).

Studies were made by the EPR method on the nature of the paramagnetic centres occurring on γ irradiation at 77°K in the monocrystal of L-tyrosine hydrochloride. The EPR spectrum of the γ-irradiated monocrystal of L-tyrosine hydrochloride consists of four components—a wide asymmetrical doublet, a singlet signal and two multiplet signals. The paramagnetic centre accounting for the first EPR signal is Cl_2^-. It has been shown that at 77°K irradiation results in the ionization of the molecule which leads to the formation of an anion-radical (singlet EPR signal) of tyrosine with localization of an unpaired electron on the benzene ring. The rupture of the C–N bond due to the capture of an electron by the charged amino group of the tyrosine molecule (multiplet EPR signal) is secondary. (auth) (UK)

15655 RADIATION-INITIATED GRAFT COPOLYMERIZATION OF BINARY MONOMER MIXTURES CONTAINING ACRYLONITRILE WITH COTTON CELLULOSE. Harris, James A.; Arthur, Jett C. Jr. (Dept. of Agriculture, New Orleans). J. Appl. Polym. Sci.; 14: 3113-28(Dec 1970).

By the use of the ^{60}Co postirradiation grafting technique, purified cotton cellulose fibers were graft-copolymerized with binary mixtures of acrylonitrile and other monomers, including styrene, 1,3-butylene dimethacrylate, vinylpyrrolidone, vinylidene chloride, and methyl, butyl, lauryl, glycidyl, and allyl methacrylates. The irradiated cotton fibers were immersed in solutions of the monomers at 25°C to initiate graft copolymerization. Solvents were water, methanol, dimethyl sulfoxide, and methyl ethyl ketone, alone or in several combinations. The extent of graft copolymerization and the composition of the grafted copolymer depended on the composition of the binary mixtures of monomers and on the solvent or mixtures of solvents used. For example, addition of styrene, 1,3-butylene dimethacrylate, or vinylpyrrolidone to acrylonitrile increased the extent of graft copolymerization to a maximum value; addition of vinylidene chloride or allyl methacrylate to acrylonitrile did not greatly affect the extent of graft copolymerization; and addition of methyl or glycidyl methacrylate to acrylonitrile increased the extent of graft copolymerization without passing through a maximum value. The proportion of acrylonitrile in the grafted copolymer was generally less than that in the binary mixtures. As the reaction time was increased, the extent of graft copolymerization increased to a maximum value; however, the composition of the grafted copolymer did not change significantly. Generally, the addition of water to the solutions increased the extent of graft copolymerization. The mechanisms of these graft copolymerization reactions are discussed. (auth)

15656 KINETIC ANALYSIS OF RADIATION-INITIATED COPOLYMERIZATION REACTIONS OF WATER-SOLUBLE VINYL MONOMERS WITH CELLULOSE. Byrne, Geoffrey A.; Arthur, Jett C. Jr. (Dept. of Agriculture, New Orleans). J. Appl. Polym. Sci.; 14: 3093-3103(Dec 1970).

A kinetic analysis of the radiation-initiated copolymerization reactions of 2-hydroxyethyl methacrylate (HEMA), hydroxypropyl methacrylate (HPMA), and methacrylic acid (MAA) from solutions of water, methanol (MeOH), N,N-dimethylformamide (DMF), dimethyl sulfoxide (DMSO), and combinations of these solvents with γ irradiated fibrous cellulose I and II was made. The maximum extent of copolymerization of HEMA and HPMA with irradiated cellulose occurred from water solutions. When organic solvents were added to the water solution and the concentration of monomer kept constant, the extent of copolymerization decreased. The maximum extent of copolymerization of MAA with irradiated cellulose occurred from mixtures of MeOH (15 to 30 vol %) and water (85 to 70 vol %) solutions rather than from water. After initiation, the copolymerization reactions were apparently diffusion controlled and exhibited second-order kinetics. The relative concentrations of grafted polymer and homopolymer formed with irradiated cellulose from aqueous solutions depended primarily on the concentration of water in the solutions. From MeOH (60 vol % or less)–water (40 vol % or more) solutions, about 60% of poly(MAA) formed was apparently grafted polymer; from solutions containing less water, the fraction of grafted polymer decreased to about 40%. (auth)

15657 RADIATION POLYMERIZATION OF CYCLOHEXADIENE. Naumova, S. F.; Erofeev, B. V.; Tsykalo, L. G. (Inst. of Physical-Organic Chemistry, Minsk). Vestsi Akad. Navuk BSSR, SSR, Ser. Khim. Navuk; No. 2, 42-6(1970). (In Russian).

Detailed data were obtained on the radiation polymerization of 1,3-cyclohexadiene (γ irradiated with a dose of 1400 R/sec at 20°C) as a function of the radiation dose with the separate consideration for formation of liquid and solid oligomer products and also considering the monomer products. (R.V.J.)

15658 EXTRACTION AND ANALYSIS OF MONOMER IN FILM DURING RADIATION GRAFTING. Guthrie, J. T.; Huglin, M. B.; Phillips, G. O. (Univ. of Salford, Eng.). Angew. Makromol. Chem.; 13: 199-202(Sep 1970).

A rapid and reproducible method is described for extracting and estimating the concentration of styrene in cellulose film, which is swollen in a typical radiation-grafting medium. (auth)

Radiolysis

Refer also to abstract 17643.

15659 (AD-713551) EFFECT OF STRUCTURE ON RADIATION CHEMICAL REACTIVITY. Klein, Nathan (Ballistic Research Labs., Aberdeen Proving Ground, Md.). 1969. 11p. NTIS.

Several aspects of the radiation chemistry of water are discussed. It is proposed that the very fast reaction of e (–) (aq) is: e (–) (aq) + H_2O (+) yields H_2O. The product of the reaction, H_2O, is an electron-hole pair, or exciton. The very large size and high mobility of the water cluster makes an encounter radius of 25A for the reaction reasonable. The existence, in aqueous solution, of both holes and excitons was proposed, although experimental evidence to date is sparse. (auth) (USGRDR)

15660 (AEC-tr-7217) INVESTIGATION CONCERNING THE RADIOLYTIC EVOLUTION OF GASES IN THE HANDLING OF MATERIALS CONTAINING PLUTONIUM. Oesterdahl, B. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Translation of report FOA-4-4419. 10p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 22669.

15661 (BNL-tr-394) RADIATION-THERMAL DECOMPOSITION OF HIGHLY FLUORINATED LIQUID AND PERFLUOROBENZENE. Aleksenko, Yu. N.; Khramchenkov, V. A. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). Translated by

S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report IAE-1977. 15p. Dep. NTIS.

Studies were made on the radiolysis of a highly fluorinated liquid of a polymeric nature, devoid of multiple bonds and having a molecular weight of approximately 1100 and a basic composition of 25% C, ~72% F, and ~0.1% H in the liquid phase at temperatures ranging from 50 to 400°C and also perfluorobenzene containing 1 to 2% of hydrogenous impurities in the liquid phase at 50°C and in the vapor phase at temperatures ranging from 300 to 600°C after irradiation with mixed n and γ radiation from a nuclear reactor. The amount of gas produced in radiolysis was determined by means of a vacuum gas burette equipped with a mercury pressure gage. Mechanisms for the formation of the gaseous products of radiolysis of fluoroorganic compounds with a fairly long carbon chain are given. In contrast to the radiolysis of the fluorinated liquid, the liquid-phase radiolysis of perfluorobenzene was characterized by a fairly high yield of high-boiling products. (P.C.H.)

15662 (CEA-R-3758) EPR AND ENDOR STUDY OF FREE RADICALS PRODUCED BY GAMMA IRRADIATION OF IMIDAZOLE SINGLE CRYSTALS. Lamotte, Bernard (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov 1970. 175p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Grenoble, France.

Gamma irradiation of imidazole single crystals at 300°K gave two radicals. Identification and detailed studies of their electronic and geometric structure were made by ESR and ENDOR techniques. A study of the hydrogen-bonded proton hyperfine tensor was made and showed the nonexistence of movement and tunneling of these protons. The principal low-temperature radical produced by gamma irradiation at 77°K was also studied by ESR. A model is proposed. (auth) (France)

15663 (COO-1385-36) ESR STUDY OF RADICALS IN γ-IRRADIATED POLYCRYSTALLINE AsF_3 AND $AsCl_3$. Subramanian, S.; Rogers, Max T. (Michigan State Univ., East Lansing. Dept. of Chemistry). [1970]. 23p. Dep. NTIS.

The free radicals produced in frozen, polycrystalline AsF_3 and $AsCl_3$ by γ irradiation were characterized by ESR and shown to be AsF_3^- and, most probably, $AsCl_3^-$. Hyperfine interactions with arsenic were observed in each case and in AsF_3^- ligand hyperfine splittings by three fluorine atoms, two of one kind and one of another, are also seen. The ESR parameters are consistent with trigonal bipyramidal structures for the radicals with the odd electron and lone pair occupying an apical and an equatorial position, respectively, and the arsenic 4d orbitals being involved in the bonding. (auth)

15664 (NP-18627) DIRECT AND RARE GAS-SENSITIZED γ RADIOLYSIS OF CYCLOPROPANE. Kuehnert, Peter (Bonn Univ. (West Germany)). 1970. 116p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis.

The direct as well as krypton- and xenon-sensitized γ radiolysis of cyclopropane was investigated. The reaction mechanisms were determined by radical and electron capture and by the use of a mixture of cyclopropane and cyclopropane-d_6. The direct and sensitized radiolyses gave the same products in differing quantitative ratios. In direct radiolysis about half of the product was formed by decay of excited cyclopropane and by reactions of the decay products. The second half originated from ion-molecule reactions. The sensitization consisted essentially of an exothermic transition of the charge of rare gas ions to the cyclopropane. As a result, a considerable accentuation of the ion-molecule reaction was observed. Ionic compounds of the rare gases with the cyclopropane or its decay products played only a subordinate role. (tr-auth)

15665 ELECTRON SPIN RESONANCE STUDY OF TRAPPED RADICALS PRODUCED BY THE RADIOLYSIS OF HYDROGENOUS MATERIALS ON POROUS GLASS. Wong, P. K. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem.; 75: 201-7(21 Jan 1971).

The γ radiolysis of water or hydrocarbons adsorbed on silica at 77°K produces trapped hydrogen atoms examinable by electron spin resonance spectroscopy. The radiolytic yields of the stabilized H atoms from water, cyclohexane, and 3-methylhexane depend on surface coverage, while that from ethane is independent of coverage from about 0.1 to 1.5 monolayer. The G(H) values (number of H atoms per 100 eV absorbed in the glass) from the hydrocarbons seemed to decrease as the molecular weight increased. Charge scavengers such as biphenyl, triphenylamine, and tetracyanoethylene (TCNE) added to the surface prior to the irradiation reduce G(H) values to about 10% of their original yield without the scavengers; argon has a parallel effect. This observation is attributed to direct competition for excitonic energy from the irradiated Vycor between the hydrogenous adsorbate and the scavenger. The stability of hydrogen atoms at 77°K depends on the nature of the surface. Some characteristics of the trapping sites are revealed by the line widths of the ESR signals and their lack of satellites. Other radicals produced in the radiolysis were also observed and their identity speculated on. (auth)

15666 RADIATION CHEMISTRY OF HYDROGEN HALIDES. Wilson, D. E.; Armstrong, D. A. (Univ. of Calgary, Alberta). Radiat. Res. Rev.; 2: 297-344(Nov 1970).

Experimental work on the radiation chemistry of hydrogen halides is reviewed with 105 references cited. An attempt has been made to correlate as far as possible the independent photochemical, kinetic, and spectroscopic studies. Only the hydrogen halides of Br, Cl, and I are reported since no data have been published for HF. Experimental techniques, product yields, and specific types of reactions occurring in radiolysis of both gases and liquids are discussed. The results of the α, γ, and x radiolysis and physical techniques used to study the ion-combination, ion-molecule, and electron-capture reactions are discussed. The reactions of irradiated HCl, HBr, and HI are analogous. (B.L.M.)

15667 RADIATION CHEMISTRY OF DYES. Grossweiner, L. I. (Illinois Inst. of Tech., Chicago. Michael Reese Hospital and Medical center, Chicago). Radiat. Res. Rev.; 2: 345-79 (Nov 1970).

The published findings on radiation decoloration of dyes in the solid state, in dye-polymer and dye-gel systems, and in dilute aqueous solutions are reviewed with particular emphasis on the primary radiolysis mechanisms in liquids. The information has been obtained from measurements of decoloration yields in the presence of selected radical scavengers and from pulse radiolysis identification of intermediates and related kinetic studies. Some discussion is presented in which dyes are used as models of high-molecular-weight biological molecules in connection with inactivation kinetics and high dose rate effects, the influence of complexing on the reactivity of hydrated electrons with dyes, and chemiluminescent dye reactions induced by ionizing radiation. Most work has been done on aqueous solutions; however, a very limited attempt has been made to relate very limited results for organic solvents to general mechanisms. 86 references are cited. (B.L.M.)

15668 PULSE RADIOLYTIC INVESTIGATIONS OF THE HYDROLYSIS OF DIRHODAN. Schoeneshoefer, M.; Beck, G.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges. Phys. Chem.; 74: 1011-15(Oct 1970). (In German).

Dirhodan, $(SCN)_2$, is formed in the oxidation of SCN^- via the well-known complex $(SCN)_2^-$: $2(SCN)_2^- \rightarrow 2SCN^- + (SCN)_2$. The hydrolysis of $(SCN)_2$ was investigated in the microsecond to second range by measuring the optical absorption of the $(SCN)_2^-$ complex and the conductivity of the solution. In acid solutions, the formation of $(SCN)_2$ is much faster than its hydrolysis. In alkaline solutions, the two processes are of comparable rate. In acid solutions, the rate of hydrolysis increases with decreasing H^+ and SCN^- concentration which is explained by the equilibrium, $(SCN)_2 + H_2O \underset{}{\overset{K}{\rightleftharpoons}} H^+ + SCN^- + HOSCN$. The constant K was found to be equal to about 6×10^{-13} M. The subsequent hydrolysis of HOSCN according to, $HOSCN + H_2O \rightarrow HSO_2^- + HCN + H^+$, proceeds with a rate constant of about 70 s^{-1}. In alkaline solutions, the equilibrium is shifted to the right-hand side, which may be due to the dissociation of HOSCN. The rate constant of the reaction $(SCN)_2 + H_2O \rightarrow 2H^+ + SCN^- + OSCN^-$ is 2.2×10^4 s^{-1}. In strongly alkaline solutions, HCN appears in its conducting form: $OSCN^- + H_2O \rightarrow HSO_2^- + H^+ + CN^-$. (auth)

15669 IONIZATION OF LIQUID ARGON BY X RAYS: $\bar{W}$ VALUE. Klassen, N. V. (National Research Council, Ottawa); Schmidt, W. F. Can. J. Chem.; 47: 4286-8(15 Nov 1969).

Liquid argon at 87°K was irradiated with 1.5-MeV x rays. Saturation currents were achieved at low dose rates. The energy required to produce an ion pair ($\bar{W}_x$) was found to be 22.5 ± 3 eV, which is similar to the gas-phase value. (auth) (Canada)

15670 EPR SPECTRA OF γ-IRRADIATED LYSOZYME CHLORIDE MONOCRYSTAL. Pulatova, M. K.; Pasoyan, V. G.; Kayushin, L. P.; Kravchenko, N. A. (Inst. of Biological Physics, Moscow. Inst. of Agrochemical Problems and Hydroponics, Erevan. Inst. of Organic Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 194: 711-14(21 Sep 1970). (In Russian).

EPR spectral studies were made on lysozyme chloride monocrystals irradiated in the temperature range 77 to 300°K. Typical EPR spectra for the γ-irradiated monocrystal at 77°K are given for two cases in which the external magnetic field is oriented in various crystallographic planes and for the changes of the temperature. (R.V.J.)

15671 MICELLAR EFFECTS ON THE REACTIVITY OF THE HYDRATED ELECTRON WITH BENZENE. Fendler, Janos H.; Patterson, Larry K. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 74: 4608-9(24 Dec 1970).

Micellar surfactants have a significant effect on the reactivity of the radiolytic hydrated electron with solubilized benzene. Half-lives of the hydrated electron and its attachment rate to benzene in these micellar solutions are determined. (D.P.O.)

15672 RADIOLYTIC DEGRADATION OF THE PEPTIDE MAIN CHAIN IN DILUTE AQUEOUS SOLUTION CONTAINING OXYGEN. Garrison, Warren M.; Kland-English, Mathilde; Sokol, Harvey A.; Jayko, Michael E. (Univ. of California, Berkeley). J. Phys. Chem.; 74: 4506-9(24 Dec 1970).

In the γ radiolysis of peptides, $RCONHCHR_2$, in quute, oxygen-saturated solution, reaction of the OH radicals at the main chain leads to formation of peptide peroxy radicals, $RCONHC(O_2)R_2$. These react preferentially via $2RCONHC(O_2)R_2 \rightarrow 2RCONHC(O)R_2 + O_2$. The alkoxy radicals are removed through the step: $O_2 + RCONHC(O)R_2 \rightarrow$ products + HO_2. Experimental evidence for these oxidation modes was derived from a detailed study of reaction stoichiometry in the γ induced oxidation of aqueous N-acetyl-DL-alanine and poly-DL-alanine. (auth)

15673 RADIOLYSIS OF AQUEOUS SOLUTIONS OF METHYL CHLORIDE. THE CONCENTRATION DEPENDENCE FOR SCAVENGING ELECTRONS WITHIN SPURS. Balkas, Turgut I.; Fendler, J. H.; Schuler, Robert H. (Carnegie-Mellon Univ., Pittsburgh. Middle East Tech. Univ., Ankara). J. Phys. Chem.; 74: 4497-4505(24 Dec 1970).

The radiolysis of 0.01 M aqueous solutions of methyl chloride produces chloride ion with a yield of 2.75 ± 0.07 which appears to result, for the most part, from reaction with electrons that escape spur recombination. This reaction occurs with a rate constant of $1 \times 10^9\ M^{-1}\ sec^{-1}$ as indicated by both competitive and optical pulse radiolysis measurements. At higher concentrations the yield increases. In presence of OH scavenger the observed increases in yield are interpreted as the result of scavenging electrons within the spurs and are in accord with the predictions of Schwarz on the spur-diffusion model. Extrapolation of the results at 0.01 M CH_3Cl to zero solute concentration gives the yield of electrons that escape spur recombination in pure water as 2.63 ± 0.07. The concentration dependence for competitive scavenging from the spur, together with the above mentioned rate constant, establishes the time dependence for reaction of electrons within the spurs. Such reaction occurs mostly in the time region 10^{-10} to 10^{-8} sec after solvation. Pulse conductivity studies show that secondary reactions do not occur on the 10^{-5} to 10^{-2} sec time scale and that the yield is independent of dose down to doses of the order of a few rads. Methyl chloride appears to be an excellent reference solute for pulse conductivity work. (auth)

15674 RADIATION CHEMISTRY OF THYMINE IN AQUEOUS SOLUTION. SOME REACTIONS OF THE THYMINE-ELECTRON ADDUCT. Loman, H. (Free Univ., Amsterdam); Ebert, M. Int. J. Radiat. Biol.; 18: 369-79(1970).

The electron and OH adducts of thymine formed on irradiation of thymine in aqueous solutions containing O_2 react rapidly with the dissolved O_2: $k(TOH + O_2) = 1.5 \times 10^9\ M^{-1}\ sec^{-1}$ and $k(T^- + O_2) = 8 \times 10^9\ M^{-1}\ sec^{-1}$. In both reactions O_2 adds to the thymine radical, producing $T(OH)O_2$ and TO_2^-. It was found that TO_2^- is ultimately converted into H_2O_2 and thymine, when the OH radicals are scavenged by a second organic solute. In the absence of O_2 and in the presence of formate or isopropanol evidence is presented that the thymine negative ion (or its protonated form) disproportionates, producing thymine and dihydrothymine. In low dose-rate, steady-state radiolysis, CO_2^- radicals destroy the chromophore of thymine in competition with a radical–radical combination reaction of CO_2^-. With the high dose-rates used in pulse-radiolysis only these radical–radical reactions can occur. (auth) (UK)

15675 FREE RADICALS IN IRRADIATED GLYCINES: A COMMENT. De Bie, M. J. A.; Braams, R. (State Univ., Utrecht). Chem. Phys. Lett.; 8: 208-10(15 Jan 1971).

In x- and γ-irradiated polycrystalline glycines the radiolytic behavior is dependent on the crystal structure and/or the extent of deuterium labeling. This is due to a selective transformation of the formed $\cdot CH\text{-}COO^-$ radical into the $H_3N^+\text{-}\cdot CH\text{-}COO^-$ radical and not to a selective decay of the $\cdot CH_2\text{-}COO^-$ radical. (auth)

15676 EPR INVESTIGATION OF IRRADIATED STRONTIUM AND ZINC ACETATE SINGLE CRYSTALS. Tolles, W. M.; Sanders, R. A.; Gisch, R. G. (Naval Postgraduate School, Monterey, Calif.). J. Chem. Phys.; 54: 1532-5(15 Feb 1971).

X-ray irradiation of strontium acetate hemihydrate produces $CH_3C\dot{O}_2^-$ and not the methyl radical as in other acetates. At higher temperatures this spectrum is replaced with two magnetically distinct $\cdot CH_2CO_2^-$ radicals. In the presence of the propionate ion, further reaction proceeds at about −30°C to yield one rotamer of one magnetically distinct $CH_3\dot{C}HCO_2^-$ radical. The ratio of propionate/acetate damage at room temperature is found to be 700:1 in strontium acetate, indicating some mechanism for the delocalization of the damage. This same reaction with a substituted propionate ion occurs in zinc acetate with a ratio of 20:1. The coupling tensors for all species are presented. (auth)

15677 OPTICAL ABSORPTION CHARACTERISTICS AND PHOTOBLEACHING BEHAVIOR OF TRAPPED ELECTRONS IN γ-IRRADIATED ALKALINE ICE. Hase, Hirotomo; Kevan, Larry (Wayne State Univ., Detroit). J. Chem. Phys.; 54: 908-14(1 Feb 1971).

Trapped electrons, e_t^-, are produced by γ irradiation of alkaline ice (10M NaOH) at 77°K. The e_t^- absorption band maximum at 590 nm shifts to shorter λ for bleaching at 700 nm and shifts to longer λ for bleaching at 400 nm. After partial bleaching, electrons can be shifted back and forth between traps characterized by long and short λ. Although this suggests at least two trap depths, there is probably a broad spectrum of trap depths. The quantum efficiency, ϕ, for photobleaching e_t^- is 0.15 and independent of λ when the optical density is measured at 590 nm. For the optical density measured at the bleaching wavelength, ϕ increases to 0.52 at 400 nm and to 0.26 at 700 nm; ϕ also increases in the presence of electron scavengers. ϕ decreases as the fraction of e_t^- bleached, F, increases and follows $\phi = 0.15 \exp(-3.7F)$ for $F = 0-0.85$. All of these changes are explained by retrapping and trap interconversion. ϕ is also independent of temperature between 4 and 77°K in agreement with photoconductivity measurements. $\epsilon(590\ nm) = 1.94 \times 10^4\ M^{-1} \cdot cm^{-1}$, and the oscillator strength is ≥0.86 for the e_t^- band. (auth)

15678 PHOTOLYSIS AND RADIOLYSIS ON PHENYLALANYLGLYCINE. Wheeler, Owen H.; Julian, Dolores A.; Ribot, Rosa Amparo (Univ., Puerto Rico, Mayaguez). Photochem. Photobiol.; 12: 505-8(1970).

A comparison was made of the photolysis and radiolysis of N-(3-phenyl-L-alanyl)glycine in aerated aqueous solution in relation to a possible energy transfer in photolysis. A comparison of the relative yields of the products showed that direct hydroxylation of N-(3-phenyl-L-alanyl)glycine and hydrolysis of the peptide bond were more favored in radiolysis, whereas oxidative cleavage was more important in photolysis. Radiolysis resulted from the attack of active species produced in the primary radiolysis of water on the solute. The various sites in the substrate competed for the radicals formed from water and the products formed were an indication of the relative reactivities of the sites in the solute. The fact that oxidative cleavage was relatively more important in photolysis indicated that the carbon radical was preferentially formed. This is in support of energy transfer postulated previously by others. (P.C.H.)

15679 ELECTRON SPIN RESONANCE OF THE CN MOLECULE TRAPPED IN GAMMA-RAY IRRADIATED POTASSIUM CYANATE. Owens, Frank; Breslow, Richard A.; Gilliam, O. R. (Univ. of Connecticut, Storrs). J. Chem. Phys.; 54: 833-6(1 Feb 1971).

Electron spin resonance (ESR) studies were made on single crystals of potassium cyanate (KNCO) that were irradiated with gamma rays at room temperature. Two ESR spectra resulted. One of these consisted of an $S = \frac{1}{2}$ center displaying a three-line hyperfine structure. This spectra is assigned to a CN molecule. The molecule occupies two sites in the lattice in which the molecular axis is parallel to the [110] and the $[1\bar{1}0]$ directions of the unit cell. The parameters of the spin Hamiltonian deduced from the spectra are $|A_{||}| = 5.0 \pm 0.5$ G, $|A_\perp| = 2.3 \pm 0.5$ G, $|A_{iso}| = 3.2 \pm 0.5$ G, and $g_\perp = 1.999 \pm .002$. The $g_{||}$ is not determined. (auth)

15680 ESR OF ^{17}O-LABELED CO_2^- RADICAL TRAPPED IN A SINGLE CRYSTAL OF SODIUM FORMATE. Schlick, S. (Israel Inst. of Tech., Haifa); Silver, Brian L.; Luz, Z. J. Chem. Phys.; 54: 867-71(1 Feb 1971).

The ESR spectrum of x-irradiated sodium formate enriched in ^{17}O is interpreted in terms of the CO_2^- radical. Two magnetically inequivalent oxygens were observed. The hyperfine tensors of ^{13}C and ^{17}O were determined and the following principal values were obtained for ^{13}C: 155, 150, and 195 G, respectively, along the axis perpendicular to the molecular plane, along the O–O direction, and along the C_2 axis. These results agree with those previously reported. For ^{17}O the magnitudes of the principal values for both oxygens are practically identical, the averages being 22.0, 23.2, and 51.0 G. The direction of the largest value is in the molecular

XUM

plane inclined at 13° to the C_2 axis. The results are used to derive the coefficients of the $4a_1$ molecular orbital containing the unpaired electron. (auth)

15681 PULSE RADIOLYSIS OF LIQUID ETHANOL: REACTION KINETICS OF THE RADICALS. Fletcher, J. W.; Richards, P. J.; Seddon, W. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem.; 48: 3765-8(1 Dec 1970). (AECL-3717).

In the pulse radiolysis of alkaline ethanol solutions the conjugate base CH_3CHO^- was not formed from the α-ethanol radical CH_3CHOH, i.e., $CH_3CHOH + CH_3CH_2O^- \not\rightarrow CH_3CHO^- + CH_3CH_2OH$. This is contrary to the observation in aqueous alkaline solutions of ethanol of a rapid equilibrium between CH_3CHOH and CH_3CHO^- The small quantity of CH_3CHO^- which is produced in the present system is consistent with the formation of the ethoxy radical CH_3CH_2O and its subsequent reaction with the ethoxide ion $CH_3CH_2O^-$. (auth) (Canada)

15682 UNSTABLE INTERMEDIATES. PART LXXXI. ELECTRON SPIN RESONANCE SPECTRA OF γ-IRRADIATED METHYL SILANES: METHYL SILYL RADICALS. Sharp, J. H.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 18, 3084-7(1970).

The major radical products on exposure of various methylsilanes to ^{60}Co γ rays are the corresponding silyl radicals formed by rupture of Si–H bonds. The ^{29}Si hyperfine tensors show that these radicals are pyramidal, with 3p to 3s ratios of ca. 5.7. It is shown that the mean R–Si–R angles are almost unaffected on replacement of hydrogen by methyl. Radiolysis of Me_2SiCl at 77°K probably also gave Me_2Si radicals, together with methyl radicals and a species thought to be Me_2SiCl. The results are compared with those for other σ-radicals of this type. (auth) (UK)

15683 EFFECTS OF FREE-RADICAL SCAVENGERS IN THE RADIOLYSIS OF SYSTEMS CONTANING PERFLUOROCYLOHEXANE Kennedy, George Alvin. Gainesville, Fla.; Univ. Of Florida (1969). 108p. University Microfilms Order No. 70-20,595.

Thesis.

A study was made on the effects of added free radical scavengers on the radiolysis products of perfluorocyclohexane and mixtures of perfluorocyclohexane and cyclohexane in the liquid phase. Samples were irradiated in pyrex vessels at 65°C with ^{60}Co γ rays. Products were identified by their gas chromatographic retention times and/or mass spectra. Product yields were determined using analytical gas chromatography; detector responses had to be estimated for a number of compounds. The major radiolysis products of pure perfluorocyclohexane and their initial G values were: perfluorobicyclohexyl, 0.95; perfluorocyclohexylhexene, 0.4 to 0.5; perfluorocyclohexylhexane, 0.1. Minor products that were detected included C_3–C_6 perfluoro-n-alkanes and numerous compounds above C_7. Many of the latter products were of the formula C_nF_{2n} (n > 6). The total G value of the minor products was estimated to be less than 1.0. In samples that contained 6 mm I in perfluorocyclohexane, formation of the radiolysis products of pure perfluorocyclohexane was prevented, and several iodine containing products were formed. The major products from the radiolysis of perfluorocyclohexane–iodine mixtures and their initial G values were: perfluorocyclohexyl iodide, 3.1; perfluorohexenyl iodide, 0.7 to 1.0; perfluorohexyl iodide, 0.1 to 0.2; and perfluorohexyl diiodide, 0.1. Minor radiolysis products of perfluorocyclohexane–iodine mixtures included $C_2F_4I_2$ and several perfluoroalkyl iodides above C_3. From a comparison of the initial rate of radioinduced uptake of iodine in perfluorocyclohexane with yields of the radiolysis products, the G value for total radical production was estimated to be between 4 and 6. Yields of the individual radicals were estimated from product yields and were: G(perfluorocyclohexyl) = 3.0, G(perfluorohexenyl) = 0.8, G(perfluorohexyl) = 0.1, and G(perfluorohexyl diradical) = 0.1. Yields of the major products from the radiolysis of perfluorocyclohexane–cyclohexane–iodine mixtures were measured as a function of the perfluorocyclohexane content. The yields of c-$C_6F_{11}H$ and c-C_6H_{11} I increased sharply with perfluorocyclohexane content up to about 30 electron % and then began to decrease. The yields of hydrogen, cyclohexene, and bicyclohexyl all decreased with increasing perfluorocyclohexane content. Except for the lack of a significant reduction in the c-$C_6F_{11}H$ yield in the presence of iodine, the results of this work were found to be consistent with previously suggested mechanisms for the radiation chemistry of perfluorocarbon–hydrocarbon mixtures. Since c-$C_6F_{11}H$ production was not reduced in the presence of iodine, perfluorocyclohexyl radicals were apparently not precursors to this product. (Diss. Abstr. Int., B)

15684 UNSTABLE INTERMEDIATES. PART LXXXII. ELECTRON SPIN RESONANCE SPECTRA OF THE SPECIES Br_2^-, I_2^-, $BrOH^-$, AND IOH^- IN γ-IRRADIATED FROZEN AQUEOUS SOLUTIONS OF ALKALI-METAL HALIDES. Marov, I.; Symons, M. C. R. (Leicester Univ., Eng.). J. Chem. Soc. A; No. 1, 201-4(1971).

Exposure of aqueous solutions of alkali metal bromides or iodides to ^{60}Co γ rays at 77 K gave hydroxyl radicals, Br_2^- or I_2^-, and species identified as $BrOH^-$ or IOH^-. The resulting magnetic parameters are compared with those for V_K centers in alkali halide crystals, and with $ClOH^-$ in strontium chloride hexahydrate. Argentic and mercuric iodide complexes in frozen aqueous solution only I_2^- under these conditions. (auth) (UK)

15685 ION LIFETIMES IN GASEOUS AMMONIA. Wilson, D. E.; Armstrong, D. A. (Univ. of Calgary, Alberta). J. Phys. Chem.; 75: 444-5(4 Feb 1971).

Second-order plots for the decay of ions in pulse-irradiated ammonia are given. A much larger ion-combination coefficient is observed for ammonia than those reported for electron–ion combinations in plasmas. Addition of oxygen gave a much reduced ion-combination coefficient. (D.P.O.)

15686 EFFECT OF CHLOROMETHANES ON HYDROGEN FORMATION IN THE RADIOLYSIS OF METHYLCYCLOHEXANE AND 3-METHYLPENTANE AT -196°C. Kimura, Toyoaki; Fukaya, Mitsuharu; Hada, Minoru; (and others) (Nagoya Univ., Japan). Bull. Chem. Soc. Jap.; 43: 3400-4(Nov 1970).

The effects of chloromethanes (CH_2Cl_2, $CHCl_3$, and CCl_4) on hydrogen formation from γ-irradiated methylcyclohexane (MCH) and 3-methylpentane (3MP) at −196°C were investigated. It was found that the decrease in hydrogen yield by the presence of CH_2Cl_2 was almost the same as that caused by an electron scavenger such as N_2O, n-butyl chloride, SF_6 or iodobenzene, but the hydrogen yield was much lower in the presence of $CHCl_3$ or CCl_4 than other electron scavengers. Although the yield of CCl_3· radicals formed from dissociative electron attachment to CCl_4 in CCl_4–MCH systems was ~1.4 G, the decrease in hydrogen yield was ~3 G. A similar result was obtained for $CHCl_3$–MCH systems. Thus the effect of CH_2Cl_2 on hydrogen formation was ascribed to electron scavenging and that of $CHCl_2$ or CCl_4 to excitation transfer as well as electron scavenging. ESR studies on radical formation from these systems also support the above interpretation. (auth)

15687 EFFECT OF RADIOACTIVE IRRADIATION ON CARDIAC GLYCOSIDES. Kotsyurba, V. A. Farmatsiya (Moscow), 16: 32-6(Nov.-Dec. 1967). (In Russian).

Strophanthin, cymarin, and erysimin solutions in a pharmacopeial concentration when irradiated in a dose range 5.3×10^{17} to 2.65×10^{18} eV/ml did not decompose in any marked degree. The same solutions, when irradiated in a dose range of 7.95×10^{19} to 1.59×10^{20} decomposed within the 50 to 85% range. Nipagin if added as an inhibitor served as a protecting agent during irradiation. (auth)

15688 REACTIVITY OF MONOCHLOROBENZENE AND ITS DERIVATIVES TOWARD SOLVATED ELECTRONS IN LOWER ALIPHATIC ALCOHOLS. Matsuoka, Haruko (Tokyo Metropolitan Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: 23-6(Jan 1971).

Monochlorobenzene and its para- or meta-substituted derivatives were irradiated with γ rays in methanol, ethanol, and n-propanol containing nitrous oxide to elucidate the reactivities of these organic solutes toward solvated electrons, and also the effect of the substituent for the aromatic nucleus on the reactivities of these solutes. The value of $G(N_2)$ decreased with increasing concentration of the organic solute. Relative rate constants of these organic solutes toward solvated electrons are determined from the competition with nitrous oxide by observing the $G(N_2)$ in these systems. Based on the results, the rate constants of the reactions of these derivatives of monochlorobenzene with solvated electrons relative to monochlorobenzene can be related to Hammett's σ function. The ρ value was observed to be 3.3, 2.1, and 1.8 for methanol, ethanol, and n-propanol, respectively. The present data, together with that by Sherman for 2-propanol, indicate that the ρ value is correlated linearly to the dielectric constant of the solvent. Some discussions are presented on the results thus obtained. (auth)

Radioisotope Production

Refer also to abstracts 15849, 15850, 17644, 17645, and 17650.

15689 RADIOCHEMICAL DETERMINATION OF YIELDS OF RARE EARTH ELEMENTS DURING FISSION OF ^{239}Pu AND ^{241}Pu BY SLOW NEUTRONS. II. YIELDS OF ISOTOPES OF RARE EARTH ELEMENTS WITH HALF-LIVES OF MORE THAN TEN DAYS. Skovorodkin, N. V.; Sorokina, A. V.; Bugorkov, S. S.; Krivokhatskii, A. S.; Petrzhak, K. A. Radiokhimiya; 12: 492-6(1970). (In Russian).

The yields of isotopes of rare earth elements from the fission of ^{239}Pu and ^{241}Pu were studied. The isotopes were ^{141}Ce, ^{144}Ce,

^{143}Pr, ^{147}Nd, ^{156}Eu, ^{91}Y, ^{147}Pm, and ^{155}Eu. The cumulative yields are given relative to the cumulative yield of ^{144}Ce. (M.C.G.)

15690 RADIOCHEMICAL DETERMINATION OF YIELDS OF RARE EARTH ELEMENTS DURING FISSION OF ^{239}Pu AND ^{241}Pu BY SLOW NEUTRONS. I. YIELDS OF ISOTOPES OF RARE EARTH ELEMENTS WITH HALF-LIVES OF LESS THAN 10 DAYS. Skovorodkin, N. V.; Sorokina, A. V.; Bugorkov, S. S.; Krivokhatskii, A. S.; Petrzhak, K. A. Radiokhimiya; 12: 487-92(1970). (In Russian).

The cumulative yields of all the isotopes were measured relative to the cumulative yield of ^{141}Ce. The yields were calculated, considering decay and the accumulation of the isotopes during irradiation and exposure. In calculating the yields for the fission of ^{241}Pu, the content of ^{239}Pu in the targets was considered. The contribution resulting from the fission of ^{239}Pu was about 5%. In targets of ^{239}Pu, the fission of the other isotopes of plutonium did not exceed 0.1%. The yields obtained are given for ^{141}La, ^{143}Ce, ^{145}Pr, ^{149}Nd, ^{149}Pm, ^{151}Pm, ^{153}Sm, ^{156}Sm, ^{157}Eu, ^{159}Gd, and ^{161}Tb. The values of the yields cited are the averages of a minimum of three experiments. The errors are given as the quadratic means. (auth)

15691 CALCULATION OF ACCUMULATION OF ISOTOPES OF TRANSPLUTONIUM ELEMENTS DURING NEUTRON IRRADIATION OF VARIOUS STARTING MATERIALS. Nikolaev, A. V.; Sokolova, V. K.; Volkov, V. V. Radiokhimiya; 12: 481-6(1970). (In Russian).

The accumulation of isotopes of transplutonium elements up to ^{244}Cm in the irradiation of ^{239}Pu, ^{240}Pu, and ^{241}Am by various neutron fluxes was investigated. It was shown that ^{240}Pu is a profitable starting material, both from the standpoint of the accumulation of isotopes and from the standpoint of the amount of poisoning of the target material by fission products. (auth)

15692 ^{68}Ga GENERATOR. Levin, V. I.; Sokolov, S. V. Radiokhimiya; 12: 505-9(1970). (In Russian).

The sorption of germanium by silica gel and zirconium dioxide was studied as a function of the germanium concentration and pH of the solution, and the sorption of gallium was studied as a function of the pH of the solution. The suitability of a number of sorbents for the creation of a generator of gallium-68 was evaluated. A method was developed for the preparation of an isotopic generator of gallium-68, using chromatographic aluminum oxide as the sorbent of germanium-68. The elution of gallium-68 from the generator was performed with a 0.005 M solution of ethylenediaminetetraacetic acid. The generator operates stably for six months. (auth)

15693 UTILIZATION OF THIN-LAYER CHROMATOGRAPHY FOR SEPARATION OF XENON TRIOXIDE FROM THE OXYGEN-CONTAINING COMPOUNDS OF IODINE. Kirin, I. S.; Isupov, V. K.; Gusev, Yu. K. Radiokhimiya; 12: 500-5(1970). (In Russian).

The possibility of using a simple and rapid method of thin-layer chromatography for preparative removal of trace amounts of labeled xenon trioxide from oxygen-containing iodine compounds and for rapid monitoring of its radiochemical purity is discussed. Iodates and periodates labeled with ^{131}I were allowed to undergo changes brought about by β decay. $^{133}XeO_3$ was also produced by neutron irradiation of sodium perxenate. (M.C.G.)

15694 SEPARATION OF CARRIER-FREE ^{88}Y FROM ZIRCONIUM TARGET BY THE METHOD OF ADSORPTION ON A FLUOROPLASTIC MATERIAL. Levin, V. I.; Kurchatova, L. N.; Malinin, A. B. Radiokhimiya; 12: 529-31(1970). (In Russian).

It was found that the quantitative extraction of yttrium is achieved on a column filled with granular Teflon without an extraction reagent as a result of sorption directly by the Teflon. Teflon was found to sorb yttrium more firmly than polyethylene. The strength of the adsorption seemed to depend on the concentration of the HF solution from which the sorption was carried out. This sorption of yttrium on Teflon was used as the basis of a chromatographic method of extraction of ^{88}Y from an irradiated zirconium target. (M.C.G.)

15695 PRODUCTION OF ^{18}F OF HIGH SPECIFIC ACTIVITY BY PHOTONUCLEAR REACTIONS. Elias, H.; Ndiokwere, Ch. L. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta; 14: 160-2(Nov 1970). (In German).

The production of ^{18}F by the reaction $^{19}F(\gamma,n)$ was accomplished with a maximum cross section of 3.5 mb at 20 MeV. Various perfluorohydrocarbon-hydrocarbon mixtures were used as targets. The percent water-extractable ^{18}F activity in relation to the H/F mole ratio was determined for several mixtures. (M.C.G.)

15696 PRODUCTION OF HIGH PURITY RADIOACTIVE ^{113m}In. Kramer, Henry Herman; Arino, Hirofumi (to Union Carbide Corp.). British Patent 1,215,354. 9 Dec 1970. Filed 1 Feb 1968.

High purity ^{113m}In in high yields was prepared by a process comprising the following steps: (1) neutron irradiation of a Sn-containing material (preferably metallic Sn) until the desired amount of ^{113}Sn is formed; (2) dissolution of the Sn-containing material; (3) dilution of the Sn solution with water; (4) contact of the diluted solution with silica gel; (5) selective extraction with dilute acid to separate ^{113m}In from the ^{113}Sn deposited on the silica gel. In steps (2) and (3) concentrated HCl may be employed, in the presence of an oxidizing agent, followed by dilution to a Sn concentration of at least 0.5 mg/ml of 0.3 to 0.5 M HCl. In step (4) a temperature of 40 to 100°C may be employed, followed by standing at room temperature. In step (5) extraction with 0.01 to 0.1 M HCl may be used. All the operations should be conducted under sterile conditions for medical use of the isotope. (UK)

15697 METHOD FOR PRODUCING RADIOACTIVE TELLURIUM. Umezawa, Hirokazu; Okashita, Hiroshi. U. S. Patent 3,545,925. 8 Dec 1970. Priority date 23 Sep 1966, Japan.

Radioactive Te is produced by dissolving a nuclear fission product containing radioactive Te in an aqueous hydrogen halide or thiocyanate solution, introducing Ni, Cu, Bi, Hg, or Ag into the solution to deposit radioactive Te selectively on the metal, separating the metal with the Te deposit from the solution, and recovering radioactive Te from the metal. (Offic. Gaz.)

15698 PREPARATION OF OIL-SOLUBLE ^{65}Zn. Michailov, M. (Reaktorzentrum, Sofia); Sorantin, H. Kerntechnik; 12: 482-5(Nov 1970). (In German and English).

Oil-soluble ^{65}Zn was prepared by neutron activation of metallic zinc, dissolution in inorganic acids, and extraction with acetylacetone, sodium diethyldithiocarbaminate, and oleic acid or naphthenic acid. At 100°C, oleic acid extracted 90%, and the naphthenic acid mixture extracted 84% of the ^{65}Zn originally present in the aqueous phase. Sodium diethyldithiocarbaminate extracted 97%, but only the zinc oleate and zinc naphthenate were found to be stable with respect to water and could be mixed with mineral and vegetable oils and used for various applications. (auth)

15699 PECULIARITIES OF THE PRODUCTION OF ^{228}Th AND ^{232}U BY NEUTRON IRRADIATION OF ^{231}Pa. Bak, M. A.; Baranov, Yu. I.; Krivokhatskii, A. S.; Shlyamin, E. A. This paper was summarized in At. Energ. (USSR); 28: 234(Mar 1970) as paper No. 373/5393. (In Russian).

A well-known method was used to calculate the accumulation of ^{232}U and ^{228}Th during irradiation of ^{231}Pa by slow-neutron fluxes in the range of 10^{13} to 10^{16} neutrons/cm^3 · sec. With the optimum flux density of 10^{14} neutrons/cm^3 · sec the highest quantity of ^{232}U is accumulated within the optimum irradiation period of 1.8 years, amounting to ~40% of the initial quantity of ^{231}Pa. The maximum yield of ^{228}Th amounts to 0.9% with a flux density of 10^{13} neutrons/cm^3 · sec for 16.5 years. When ^{231}Pa is irradiated for one year by a flux of 10^{14} neutrons/cm^3 · sec in a loop with constant thorium concentration and continuous extraction of ^{232}U from the irradiated volume, the ^{232}U yield is equal to about 63% (the corresponding equilibrium quantity of ^{228}Th is 1.46%), compared with the 35% obtained when protactinium lumps are irradiated under the same conditions. The quantity of ^{228}Th corresponding to the ^{232}U quantity accumulated in equilibrium with it was calculated. From 1 g ^{232}U (energy release 4.8 W) 25.8 mg ^{228}Th (energy release 4.2 W) was obtained. The results are tabulated. (auth)

15700 ^{123}I PRODUCTION FOR PHARMACEUTICAL USE. Sodd, V. J. (Cincinnati General Hospital. Dept. of Health, Education, and Welfare, Cincinnati); Blue, J. W.; Scholz, K. L. pp 125-37 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

A method for cyclotron production of ^{123}I using two reactions $^{121}Sb(^4He, 2n)^{123}I$ and $^{122}Te(d, n)^{123}I$ is discussed. The former reaction was studied by bombarding 98.4% isotopically-enriched ^{121}Sb powder targets with 25.2 to 36.5 MeV α particles. The ^{123}I yield from ^{121}Sb targets (19 to 70 mg/cm^2) ranged from ~0.2 to 0.9 mCi/μAh. The ^{124}I, ^{125}I, and ^{126}I contaminants could be limited to 0.5, 0.02, and 0.002% respectively at the end of bombardment by controlling the thickness of the target (15 mg/0.7 cm^2) and the energy of the α-particle beam. The second reaction was studied at the same machine by bombarding 95.4% isotopically-enriched ^{122}Te powder targets with 6.4 to 9.0 MeV deuterons.

XUM

The ^{123}I yield from targets of thickness between 18 and 45 mg/cm^2 ranged from 0.002 to 0.13 mCi/μAh. At the bombarding energy of 6.8 MeV, the maximum levels of ^{124}I, ^{125}I, ^{126}I, ^{130}I, and ^{131}I contaminants were 0.09, 0.02, 0.04, 0.9, and 0.09% respectively. Also presented are Ge(Li) γ-ray spectra of ^{123}I, and chemical procedures for isolating radiopharmaceutical ^{123}I from the target material and for the recovery of ^{121}Sb. (UK)

15701 ^{123}I PRODUCTION FROM THE β^+ DECAY OF ^{123}Xe. Blue, J. W. (Lewis Research Center, Cleveland); Sodd, V. J. pp 138-47 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

Two arrangements are presented for the production of ^{123}Xe which appear to be well suited to the production of large amounts of ^{123}I. The tellurium target need not be chemically dissolved and therefore can be re-used for subsequent bombardments. Both arrangements use the reactions $^{122}Te(\alpha, 3n)$, $^{122}Te(^3He, 2n)$, or $^{123}Te(^3He, 3n)$ to produce ^{123}Xe, which is then physically separated from the tellurium target by diffusion from the microcrystal, and subsequently transported in a helium gas stream to low-temperature traps. After a time the ^{123}I produced from the β^+ decay of ^{123}Xe is removed from the trap. Direct labelling of organic molecules is possible, and macroaggregated serum albumin was labelled with ^{123}I merely by contacting a solution with the contents of the trap. (auth) (UK)

15702 SOME PROBLEMS OF RbCl TARGETS IRRADIATED WITH DEUTERONS IN THE CYCLOTRON. Hruby, J. J. (Inst. of Nuclear Research, Rez, Czech.). pp 149-58 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

Deuteron irradiations of molten RbCl without a protecting metallic foil were performed in the extracted beam in the U-120 cyclotron. The target technique used is briefly described. γ-spectra and decay curve analysis were used to identify the following radionuclides in the irradiated target: ^{84}Rb, ^{86}Rb, ^{88}Rb, ^{85m}Sr, ^{85}Sr, ^{87m}Sr, and ^{38}Cl. For some the "saturation activity per μA" was estimated (^{87m}Sr – 6.4 mCi/μA, ^{85m}Sr – 23.5 mCi/μA, ^{38}Cl – 14.9 mCi/μA) as well as the total thick-target yield for the production of ^{85}Sr (15 μCi/μAh). The losses of the activity produced (^{85}Sr) and of the target material were studied. Attempts were made to find the optimum conditions for irradiation (other Rb salts, especially in mixtures, pretreatment of target, and programmed irradiation). These aspects are discussed from the viewpoint of optimising the production of ^{85}Sr. (auth) (UK)

15703 ISOTOPE PRODUCTION IN THE HARWELL VARIABLE ENERGY CYCLOTRON (V.E.C.). Jenkins, I. L.; Wain, A. G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 168-82 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The V.E.C. is primarily a research machine but it has been used for a limited isotope production programme. Production is restricted to those isotopes which the U.K.A.E.A. needs for research purposes and which are not easily available from other sources. The irradiation and processing facilities provided by the V.E.C. and some of the irradiations that have been carried out are described. Yields of 60 μCi of ^{236}Pu and 72 μCi of ^{235}Np were obtained by irradiating metallic targets of natural uranium with 50 MeV protons. Proton beams of lower energy (<15 MeV) were used to produce millicurie amounts of ^{56}Co by the $^{56}Fe(p,n)^{56}Co$ reaction, and excitation functions for some of the proton-induced reactions of ^{56}Fe were determined. Proton and deuteron bombardments of ^{151}Eu were used to prepare ^{151}Gd, and millicurie quantities were made by the $^{151}Eu(d, 2n)^{151}Gd$ reaction using an oxide target. Small amounts of isotopes such as ^{140}Nd, ^{87}Y, and ^{66}Ga were also produced. (auth) (UK)

15704 TERMS USED IN THE PRODUCTION OF RADIOISOTOPES BY CHARGED-PARTICLE BOMBARDMENT. Sovoboda, K. (Inst. of Nuclear Research, Rez, Czech.). pp 383-94 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The incomplete definition of thick target yield, Y, has led to the proposition of the term production rate, R, where $R = Y/\lambda$, λ being the radioactive constant. The relative merits of R and Y are considered. In estimating R, experimentally significant errors arise, and a table is given illustrating the variation in Y for several radioisotopes (production runs and external bombardment). Discrepancies in some estimates of Y given by different authors are also tabulated. The coefficient ϵ, the ratio of individual estimates of the Y estimated in the external beam at low beam intensity, and its effect on the estimation of R is discussed. Proposal of terms and units for possible approval are given. Discussion following presentation of the paper is summarised. (UK)

Recoil Production and Reactions

15705 (COO-1620-6) CHEMICAL EFFECTS OF THE NUCLEAR REACTION $^{14}N(n,p)^{14}C$ IN VARIOUS NITROGENOUS COMPOUNDS. Progress Report, May 1, 1970–April 30, 1971. Vaughan, John D. (Colorado State Univ., Fort Collins. Dept. of Chemistry). 15 Jan 1971. Contract AT(11-1)-1620. 3p. Dep. NTIS.

Reactions of recoil ^{14}C in potassium azide were studied and tetrazale was irradiated for a similar study. (M.C.G.)

15706 REACTIONS OF IODINE ACTIVATED BY RADIATIVE NEUTRON CAPTURE AND ISOMERIC TRANSITION WITH GASEOUS AND CONDENSED STATE POLYHALOMETHANES. Parks, Norris Jim. Lincoln, Neb.; Univ. of Nebraska (1969). 141p. University Microfilms Order No. 70-12,280.

Thesis.

The organic yields of $^{130}I + ^{130m}I$ activated by radiative neutron capture and those of ^{130}I activated by isomeric transition were found to decrease for the liquid systems studied in the order $CH_2Cl_2 > CHCl_3 > CFCl_3 > CCl_4 \cong CCl_3Br$. The organic yields of (n,γ) activated $^{130m}I + ^{130}I$ are consistently lower than the (IT) induced yields of ^{130}I. The products and their relative abundance were determined by radiogas chromatographic analysis. These determinations, together with other considerations, suggest the observed results may be primarily ascribed to variations in product stability, which are related to variations in steric interactions among substituents of product molecules. The reactions of (n,γ) activated ^{128}I with gaseous CH_3X, CH_2X_2, CHX_3, and CX_4 (X = F and/or Cl) were examined. The comparisons of total organic yields and indications that halogen replacement products are preferentially formed suggest that steric interaction between substituents of both reactant and product molecules is also an important factor controlling the extent of reaction in gaseous systems. The organic yields were found to decrease with increasing halogen substitution for the homologous halomethane series studied. The similar yields of isomeric transition induced reactions of ^{130}I and the radiative neutron capture induced reactions of ^{128}I in liquid systems, and the finding that additives capable of efficient charge transfer reaction with the activated species in the gas phase effectively inhibit (n,γ) induced reaction of ^{128}I with the target system are indications that the reactive species are ions possessing excess kinetic and/or electronic energy. (Diss. Abstr. Int., B)

15707 ISOTOPE EFFECT IN THE RETENTION OF RADIOXENON IN NEUTRON-IRRADIATED AQUEOUS XENON TRIOXIDE. Heitz, Ch.; Casson, M. (CRN, Strasbourg). Inorg. Nucl. Chem. Lett.; 7: 47-51(Jan 1971).

The samples (one cm^3 of 0.15 M XeO_3 in water) were irradiated for 10 min in a thermal neutron flux of 10^{12} n cm^{-2} sec^{-1}. The released radioxenon was trapped at liquid nitrogen temperature and the evolution of the activity of the gas and of the aqueous solution was followed for 40 days. The retention of seven isotopes or isomers of Xe (125, 127, 129m, 131m, 133m, 133, 135) were computed and are tabulated, the isotope effect being expressed relative to ^{125}Xe. The table also includes the excitation energy of the compound nucleus and the spin change between the compound nucleus and the product in the ground state. The results are discussed. (UK)

15708 SZILARD-CHALMERS REACTIONS IN AROMATIC IODO COMPOUNDS. Wheeler, O. H.; Lecumberry, C. (Puerto Rico Nuclear Center, Mayaguez). Contract AT(40-1)-1833. Radiochim. Acta; 14: 119-22(Nov 1970).

The radioactive products formed in the neutron activation of iodobenzene, iodosobenzene, iodoxybenzene, and diphenyliodonium iodide were analyzed. The radiochemical yield of zero valent iodine was 13 to 25%, and iodine was not an effective scavenger for hot iodine atoms. The anionic yield was only appreciable for

iodoso- and iodoxybenzene, and was largely iodide and iodate. The main labeled product in all cases was iodobenzene. Some labeled iodosobenzene was formed from iodoxybenzene. These products resulted from recombination reactions. (auth)

15709 RESOLUTION OF AN INCONSISTENCY IN RECOIL TRITIUM REACTIONS. Wolfgang, Richard (Yale Univ., New Haven). J. Phys. Chem.; 74: 4601-3(24 Dec 1970).

A rebuttal to Root and Rowland [J. Phys. Chem., 74: 451(1970).] (NSA 24: 9401) dealing with an inconsistency in recoil tritium reactions in methane–hydrogen systems is given. (D.P.O.)

15710 INAPPLICABILITY OF THE SIMPLE KINETIC THEORY OF HOT REACTIONS TO CERTAIN BINARY RECOIL TRITIUM SYSTEMS. Rowland, F. S. (Univ. of California, Irvine). Contract AT(04-3)-34. J. Phys. Chem.; 74: 4603-5 (24 Dec 1970).

Comments are given on a previously published paper [J. Phys. Chem., 74: 451(1970)] (NSA 24: 9401) concerning the inapplicability of the simple kinetic theory of hot reactions to certain binary recoil tritium systems. (D.P.O.)

15711 EVIDENCE FOR ^{11}C STRIPPING AND ABSTRACTION REACTIONS LEADING TO ACETYLENE FORMATION. Lambrecht, R. M.; Furukawa, N.; Wolf, A. P. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem.; 74: 4605-8(24 Dec 1970).

The relative distribution of three isotopic acetylenes ($^{11}C_2H_2$, $^{11}C_2D_2$, and $^{11}C_2HD$) resulting from reactions of 50/50 mixtures of various perprotonated and perdeuterated alkanes and benzene with ^{11}C recoils under various experimental conditions are given. The origin of $^{11}C_2HD$ is discussed. (D.P.O.)

15712 RECOIL REACTIONS IN NEUTRON-ACTIVATED NICKEL CARBONYL. Wheeler, O. H. (Puerto Rico Nuclear Center, Mayaguez); Trabal, J. E.; Wiles, D. R. Can. J. Chem.; 48: 3609-12 (1 Dec 1970).

Retention of ^{65}Ni in neutron-irradiated $Ni(CO)_4$ was measured both in the pure form and in n-heptane of $Fe(CO)_5$ solutions, and mixed with triphenylphosphine ($P\phi_3$) in n-heptane solution. Retention was found to be nearly 100% in all cases except with high concentrations of $Fe(CO)_5$, where the retention dropped off strongly. It is concluded that the high retention is the result of rapid exchange of CO with inactive $Ni(CO)_4$. The effect of $Fe(CO)_5$ is considered to be a hot-zone reaction. The presence of triphenylphosphinenickel tricarbonyl was found not to affect the retention in $Ni(CO)_4$. This is taken to show that the ^{65}Ni atoms formed in crystalline $\phi_3PNi(CO)_3$ remain trapped in the lattice. (auth) (Canada)

15713 SECONDARY UNIMOLECULAR REACTIONS SUBSEQUENT TO SUBSTITUTION REACTIONS BY HIGH-ENERGY ^{38}Cl AND ^{39}Cl ATOMS. Tang, Yi-noo (Texas A and M Univ., College Station); Smith, W. S.; Williams, J. L.; Lowery, K.; Rowland, F. S. Contracts AT(40-1)-3898; AT(11-1)-34. J. Phys. Chem.; 75: 440-2(4 Feb 1971).

With each of four molecular targets, dichloromethane, chloroethane, dichloroethane, and cyclobutane, and using ^{38}Cl or ^{39}Cl as the energetic recoil species, secondary unimolecular processes were observed following the ^{38}Cl for Cl, ^{39}Cl for H, and ^{39}Cl for H substitution reactions. The pertinent data are summarized. (D.P.O.)

15714 CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS IN SOLIDS: CONTRIBUTION TO SOLID-STATE PHYSICS. I. Mueller, Horst (Univ., Freiburg i. B.). Atomkernenergie; 16: 237-42(1970). (In German).

The physical fate of atoms with kinetic energy can be investigated by producing radioactive recoil atoms in nuclear reactions. By utilizing suitable chemical compounds, new radioactive-labelled species may be synthesized, the kind and amount of which allow conclusions concerning the physical processes in the solid. The initial kinetic energy may be varied in some limits by the releasing nuclear reaction. The experiments supply some qualitative and quantitative results on displacement energies, replacement reactions, recoil ranges, size, and structure of reaction zones and confirm physical models of solid-state damage. (auth)

15715 PREPARATION OF SOME MERCURI-DERIVATIVES OF FLUORESCEIN LABELLED WITH ISOTOPES ^{197}Hg AND ^{203}Hg. III. RECOIL-LABELLING OF DERIVATIVES. Kronrad, L.; Ratusky, J.; Malek, P.; Vavrejn, B.; Kolc, J. J. Label. Compounds; 6: 326-32(Oct-Dec 1970).

The possibility of preparation of mercury derivatives of fluorescein labeled with ^{197}Hg by irradiation of the respective compounds in a nuclear reactor was studied. For all compounds investigated, specific activity high enough could be obtained without any significant radiation decomposition. In cases, when the target molecule contained more than one target atom, bis(hydroxymercurifluoresceinyl) mercury and bis(hydroxymercurifluorescein), a higher enrichment factor for some products could be obtained. The recommended procedure for preparation of difluoresceinylmercury-^{197}Hg by this method has been given. (auth)

15716 SLOWING DOWN OF ATOMS WITH E < 15 eV IN SOLIDS. Langhoff, H. (Bartol Research Foundation, Swarthmore, Pa.). Z. Phys.; 241: 236-43(1971).

The nuclear resonance fluorescence method was applied to study the profiles of γ emission lines. Under certain conditions these profiles contain information about the slowing down of recoiling atoms in solids. The 773-keV line emitted by sources of ^{187}W, ^{187}WC, and $^{187}WO_3$ was investigated. The results for this line and available data for ^{152}Eu, ^{152}EuO, and $^{131}I(Te)$ sources are discussed using a simple description for the slowing down based on the Debye model. (auth)

15717 DEPENDENCE OF THE CHEMICAL BEHAVIOUR OF MOLYBDENUM RECOIL ATOMS IN METAL CARBONYLS ON THE ENERGY AND THE ISOTOPE. Henrich, E.; Wolf, G. K. (Univ., Heidelberg. Kernforschungszentrum, Karlsruhe, Ger.). pp 51-60 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

Different isotopes recoiling from nuclear reactions sometimes show a difference in their chemical behaviour. In order to study the causes of this difference target elements ranging from molybdenum to indium were irradiated in close contact with $Cr(CO)_6$ with 600 MeV protons. ^{90}Mo and ^{93m}Mo recoils atoms, with energies dependent on the mass difference between target and product, reacted with the $Cr(CO)_6$ forming $Mo(CO)_6$. The yield of this reaction was determined for the individual isotopes and their recoil energy. $MO(CO)_6$ was also irradiated with 600 MeV protons, fast neutrons, and thermal neutrons. The percentage of ^{90}Mo, ^{93m}Mo, and ^{99}Mo having the configuration of the target (retention) was measured for the individual isotopes and the irradiation conditions. In all cases the retention of ^{93m}Mo was higher than that of ^{90}Mo and ^{99}Mo. The magnitude of this isotope effect was independent of the recoil energy and the irradiation conditions. The existence or nonexistence of nuclear levels having sufficient lifetime ($<10^{-12}$ s) in the de-excitation cascade of the excited recoiling isotopes is quoted as a cause of their different chemical behavior. (auth) (UK)

Radiochemistry

Refer also to abstracts 15693, 15706, 15964, and 17642.

15718 SOURCE MATERIAL FOR RADIOCHEMISTRY. 1970 REVISION. Nuclear Science Series Report Number 42. Washington, D. C.; National Academy of Sciences (1970). 117p.

A listing of books, journals, monographs, reviews, conference proceedings, nuclear data compilations, laboratory manuals, and bibliographies on radiochemistry in the fields of nuclear chemistry and nuclear physics is given. The various subjects covered include radiochemistry, nuclear chemistry, and nuclear physics; nuclear data compilations; nuclear particle detectors, counting techniques, and data reduction; radiochemical separation procedures; ion exchange, solvent extraction, and other chromatographic methods; activation analysis; earth and space sciences; laboratory design and equipment; and radiological safety. A brief list on where and how to obtain radioactive and separated stable isotopes is also included. With one exception only readily available literature in the English language is included. The collected references are not intended to be a comprehensive listing but represent a selection which members of the Subcommittee on Radiochemistry have found the most useful. (P.C.H.)

15719 FREE ENERGIES OF FORMATION OF HYDROUS OXIDES OF TECHNETIUM IN ITS LOWER VALENCIES. Cartledge, G. H. (Oak Ridge National Lab., Tenn.). J. Electrochem. Soc.; 118: 231-6(Feb 1971).

It was found possible to measure reversible electrode potentials for couples containing technetium and one or more of its hydrous oxides. The procedure disclosed the existence, in films, of technetium in 1+, 2+, and 3+ valence states, besides oxides Tc_3O_4 and Tc_4O_7, and provided direct means for evaluating their free energies of formation from the metal. The previous calorimetrically based free energy of formation of $Tc(OH)_4$ was confirmed to within 1%. It was found that the radioactivity of technetium is involved in certain processes on the electrode. (auth)

XUM

Separation Processes

Refer also to abstracts 15475, 15481, 15507, 15508, 15561, 15562, 15570, 15631, 15632, 15693, 15694, 15697, 15718, 15817, 15818, 16116, 16307, 17257, 18034, 18043, 18100, and 18138.

15720 (ARH-1552) PALLADIUM RECOVERY FROM ALKALINE PUREX WASTES BY SORPTION ON ACTIVATED CHARCOAL. Panesko, J. Vincent (Atlantic Richfield Hanford Co., Richland, Wash.). Jul 1970. Contract AT(45-1)-2130. 12p. Dep. NTIS.

Palladium was selectively recovered from alkaline Purex wastes by activated charcoal. A loading of 1.1 grams palladium per pound of charcoal was obtained at 50% palladium breakthrough. Quantitative palladium removal was achieved by elution with H_2O and NH_4OH. (auth)

15721 (DP-1248) HYDROXYLAMINE NITRATE AS A PLUTONIUM REDUCTANT IN THE PUREX SOLVENT EXTRACTION PROCESS. McKibben, J. M.; Bercaw, J. E. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan 1971. Contract AT(07-2)-1. 22p. Dep. NTIS.

In laboratory tests, followed by a plant demonstration, hydroxylamine nitrate was shown to be superior to hydroxylamine sulfate for plutonium reduction in the second plutonium cycle of the Purex solvent extraction process. Hydroxylamine nitrate chemical reactions, stability, and rates of plutonium reduction were determined. (auth)

15722 (KFK-1291) COMPLEXES OF TRIVALENT TRANSURANIUM ELEMENTS WITH AMINOPOLYCARBOXYLIC ACIDS. Bayat, Iradj (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Sep 1970. 46p. (In German). Dep. NTIS (U. S. Sales Only).

Stability constants of the complexes of tervalent actinides (Am(III)-Cf(III)) with 11 aminopolycarboxylic acids are reported and rules for the dependence of complex stability and complex composition on the structure of the ligand are given. The coordination number of the central ions of the complexes was derived from spectrophotometric data and by correlation of the stability constants. Separation factors for Am/Cm were calculated from stability constants and ion exchange distribution coefficients for several aminopolycarboxylic acids. (auth)

15723 (NACAR-10007) REVIEW OF RADIOACTIVE NOBLE GAS COLLECTION PROCESSES. Kovach, J. Louis (North American Carbon, Inc., Columbus, Ohio. Research and Development Dept.). 15 Oct 1970. 33p.

A review is presented on collection processes that were or are being evaluated to prevent release of radioactive Kr and Xe isotopes during the operation of nuclear reactors, nuclear fuel reprocessing facilities, or incident conditions of nuclear reactors. These processes include: absorption in halogenated solvents; adsorption at ambient temperature; adsorption at reduced temperature; adsorption at cryogenic temperature; compression in pressure vessels; condensation at cryogenic temperatures; foam encapsulation; isotope exchange; permselective membrane separation; and miscellaneous processes. Each process is described and then evaluated. It was concluded that, with the exception of the ambient or reduced temperature adsorbers, all the other systems create a high activity concentrated Kr, Xe isotope storage and transport problem. (P.C.H.)

15724 (NP-18621) SUITABILITY AND RELIABILITY OF INSTALLATIONS FOR TREATMENT OF RADIOACTIVE WASTE. Aurand, K.; Arndt, J.; Wolter, R. (Bundesgesundheitsamt, Berlin (West Germany). Institut fuer Wasser-, Boden- und Lufthygiene,. Jul 1970. 21p. (In German). Dep. NTIS (U. S. Sales Only).

Studies on the treatment and disposal of radioactive wastes are discussed. Sources of the waste, use of radioisotopes, tankage capacity, installation equipment, control of aqueous wastes, economics of waste processing and disposal, and safety procedures are considered. (M.C.G.)

15725 (NP-18656) STUDY ON THE EXTRACTION OF RUTHENIUM-NITROSYL COMPLEXES FROM $UO_2(NO_3)_2$-3N HNO_3 BY 10 TO 20v/o TBP/n-DODECANE. Tsuboya, Takao; Hiroki, Toshio; Hoshino, Tadaya (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Nov 1970. 26p. (In Japanese). (N-841-70-31). Dep. NTIS (U. S. Sales Only).

The behavior of ruthenium in the extraction step with an extractant of 10 to 20 vol % TBP (tri-n-butyl phosphate)-n-dodecane was studied. The problem arising from ruthenium in the Purex Process lies in the fact that the composition of ruthenium complexes in the feed solutions may vary with slightly different conditions and their behavior in the extraction steps differ. The extraction coefficients (E) of extractable ruthenium complexes in uranyl nitrate-nitric acid solutions were investigated. Only higher nitrato complexes and the dinitro complex (designated by D. Scargill, et al.) are extractable from the aqueous phase at high uranyl nitrate concentrations and 3N nitric acid by 10 to 20 vol % TBP-n-dodecane. Their extraction coefficients depend strictly on the free TBP concentration. (auth)

15726 (ORNL-4622, pp 199-225) MOLTEN-SALT PROCESSING AND PREPARATION. (Oak Ridge National Lab., Tenn.).

From Molten-Salt Reactor Program.

Progress is reported on the development of a process for the isolation of protactinium and the removal of fission products from molten salt reactors; distribution of rare earths between liquid bismuth solutions and molten lithium chloride; development of contactor; development of a continuous fluorinator; and engineering experiment for study of the metal transfer process for removing rare earths from single-fluid MSBR fuel salt. (D.H.M.)

15727 (ORNL-TM-3226) APPLICATION OF ION EXCHANGE FOR RECYCLE OF 2-ETHYL-1-HEXANOL TO SOL-GEL PREPARATION OF SPHERES. Luina, A. P.; Haas, P. A.; Haws, C. C. Jr. (Oak Ridge National Lab., Tenn.). Feb 1971. Contract W-7405-eng-26. 27p. Dep. NTIS.

Formic and nitric acid must be removed from 2-ethyl-1-hexanol (2EH) in order to recycle 2EH during formation of sol-gel oxide spheres from UO_2 sols. Conditions were determined for using Amberlite IRA-93 or Amberlyst A-21 anion exchange resins to remove the formic and nitric acids. Complete operating cycles were demonstrated in 1-in.-ID and 4-in.-ID ion exchange columns of 24-in. lengths. Breakthrough of the formic acid is determined by measuring the effluent 2EH pH; control of the regeneration cycle is by use of preset solution volumes. (auth)

15728 (ORO-678, pp 102-13) CONDITIONS AFFECTING Cs AND Na FIXATION IN HYDROBIOTITE AND VERMICULITE. Klobe, W. D. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1-December 31, 1969.

Studies were made on the mechanism responsible for Cs and Na fixation, the effects of different chemical environments on the amount of fixation, and the significance of fixation reactions in soils, as they affect the availability of nutrient cations and fission products. The results showed that over 95% of the sorbed Cs was fixed above 1% Cs saturation of the exchange capacity, regardless of K levels or whether the K was in the form of residual K in hydrobiotite or K added to vermiculite prior to addition of the Cs. There was a decrease in fixation at trace levels of Cs (i.e., carrier-free ^{137}Cs), indicating that it may be more available for plant uptake. X-ray and Na-fixation results indicated that Cs saturations below 40% of the exchange capacity resulted largely in interstratified Na- and Cs-rich layers with little edge collapse. Higher Cs saturations resulted in increased edge collapse and Na entrapment. Formation of interstratified layers vs edge collapse of the particles tended to be associated with smaller (0.2- to 5.0-μ) and larger (5- to 62-μ) particles, respectively. (P.C.H.)

15729 (UCRL-Trans-10509) SEPARATION OF URANIUM AND RARE-EARTH ELEMENTS ON SULFONIC KU-2. III. Krawczyk-Obojska, Irena. Translated by A. M. Mincer for Univ. of California, Lawrence Radiation Lab., Livermore, from Chem. Anal. (Warsaw); 13: 551-6(1968). 10p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 47215.

15730 (UCRL-Trans-10512) PRECIPITATION OF CERIUM FROM RARE-EARTH NITRATE SOLUTIONS BY HYDROLYSIS IN THE PRESENCE OF HYDROGEN PEROXIDE. Golinski, M.; Korpak, W. Translated by A. M A. Mincer for Univ. of California, Lawrence Radiation Lab., Livermore, from Przem. Chem.; 46: No. 6, 328-32(1967). 21p. Dep. NTIS.

Conditions were established for the separation of cerium from rare earth (RE) nitrate solutions obtained after separation of the main part of the Ce by extraction with TBP. The conditions for the oxidation of Ce(III) with hydrogen peroxide in solutions containing 142 to 166 g/l Ln_2O_3, 4 to 20 g/l Ce(III), and 3.5M ammonium nitrate were examined. It was found that the excess of hydrogen peroxide needed for the oxidation and precipitation of Ce(III) decreased with increasing pH and cerium concentration. In relation to the stoichiometric quantity, this excess varies from 300 to 800%, depending on the cerium content and temperature. The optimum pH for cerium precipitation at 98°C was between 6.05 to 6.15 and 6.6 to 6.7 when the cerium concentration varied from 4 to 20 g/l. By adding hydrogen peroxide to the solution at room temperature, and subsequent boiling of the suspension for 0.5 to 1 hr, a significant economy in H_2O_2 consumption was

obtained, the yield of the cerium precipitation being ca 99%. (auth)

15731 (UCRL-Trans-10513) EFFECT OF THE NATURE OF THE RETAINING ION ON THE DISPLACEMENT CHROMATOGRAPHIC SEPARATION OF LANTHANIDES WITH EDTA. Bruecher, E.; Szarvas, P. Translated by Z. Gallay for Univ. of California, Lawrence Radiation Lab., Livermore, from Magy. Kem. Foly.; 75: No. 2, 63-6(1969). 14p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 19838.

15732 (WHAN-FR-34) EFFECT OF FABRICATION VARIABLES ON THE DISSOLUBILITY OF UNIRRADIATED MECHANICALLY BLENDED MIXED OXIDE FAST REACTOR FUEL. Lerch, R. E.; Schiefelbein, G. F. (WADCO Corp., Richland, Wash.). Dec 1970. Contract AT(45-1)-2170. 64p. Dep. NTIS.

A statistical, fractional factorial experiment was performed to determine the effect of six fuel fabrication variables on the dissolubility of unirradiated, mechanically blended PuO_2-UO_2 fuels. The six fabrication variables were source of PuO_2, PuO_2 content, sintering temperature, sintering time, rate of temperature rise during sintering, and pellet pressing pressure. All six fabrication variables had some effect on pellet dissolubility with source of PuO_2, PuO_2 content, and sintering temperature having major effects. (auth)

15733 EXTRACTION CAPABILITY OF SULFOXIDES. II. THERMODYNAMICS OF THE EXTRACTION. Rozen, A. M.; Murinov, Yu. I.; Nikitin, Yu. E. Radiokhimiya; 12: 513-16 (1970). (In Russian).

The extraction of uranyl nitrate by three cyclic and two aliphatic sulfoxides was studied. All the sulfoxides form a disolvate with uranyl nitrate; the effective extraction constants are from 1000 for aliphatic sulfoxides to 5000 for cyclic sulfoxides. The heats of extraction of aliphatic and cyclic sulfoxides proved to be practically the same. Thus, the increase in the extraction capacity as we go from aliphatic sulfoxides to cyclic sulfoxides is due to the action of the entropy factor. (auth)

15734 EXTRACTION CAPABILITY OF SULFOXIDES. III. EXTRACTION OF THORIUM AND ZIRCONIUM NITRATE AND TELLURIUM CHLORIDE. Rozen, A. M.; Murinov, Yu. I.; Nikitin, Yu. E. Radiokhimiya; 12: 516-18(1970). (In Russian).

The isotherms of the extraction of thorium nitrate, zirconium nitrate, and tellurium chloride by alkyl sulfoxides were obtained, and for thorium nitrate the isotherm of extraction by a cyclic sulfoxide was also obtained. The extraction constants were evaluated. It was found that in all cases disolvates are formed. Just as in the extraction of uranyl nitrate, the sulfoxides significantly surpass TBP in extraction capacity. (auth)

15735 REPROCESSING OF OXIDE FUEL AT WINDSCALE. Hughes, T. G.; Kemp, E. F. Atom (London); 168: 206-11(Oct 1970). (CONF-700903-7).

From 4th Foratom Congress on Industrial Aspects of the Nuclean Fuel Cycle in Europe, Stockholm, Sweden.

The plant was designed so that the product from the single-cycle Butex extraction would be collected batchwise and fed on a campaign basis into the main TBP/OK reprocessing unit. Plant design and construction problems, plant features, and future developments are discussed. (M.C.G.)

15736 ION EXCHANGE METHOD FOR SEPARATING URANIUM ISOTOPES. Shimokawa, Junichi; Nishio, Gunji; Kobayashi, Fumiaki. U. S. Patent 3,511,620. 12 May 1970. Priority date 30 Jul 1964, Japan.

A cation exchange resin carrying adsorbed cations of U(IV) is contacted with an acid solution of U(VI) cations having an acidity not substantially above 1 N. Shortly thereafter, a higher proportion of ^{235}U is found in the dissolved U than in the adsorbed U, the ratio being 1.0007:1 at isotope equilibrium. Natural U is thus separated into fractions respectively enriched with, and depleted of, ^{235}U by countercurrent flow of resin and solution in multiple stages. (Offic. Gaz.)

15737 EXTRACTION OF SELENIUM(IV) AND TELLURIUM(IV) WITH THIONAPHTHENIC ACIDS. Zolotov, Yu. A.; Alekperova, A. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow. Inst. of Inorganic and Physical Chemistry, Baku). Zh. Anal. Khim.; 26: 131-3(Jan 1971). (In Russian).

The extraction of tellurium(IV) and selenium(IV) with thionaphthenic acids from solutions in HCl and H_2SO_4 has been examined. The composition of the extracted compounds has been established. The optical characteristics of tellurium compounds in CCl_4 have been studied. A selective extraction method for separating selenium and tellurium and for their separate determination has been developed. (auth)

15738 CONCERNING SYNERGISM DURING EXTRACTION OF THORIUM FROM NITRATE SOLUTIONS BY EQUIMOLAR MIXTURE OF BIS(2-ETHYLHEXYL) PHOSPHATE-TBP IN KEROSENE. Bykhovtsov, V. L. Radiokhimiya; 12: 539-40 (1970). (In Russian).

Data are presented on the extraction of thorium by an equimolar mixture of bis(2-ethylhexyl) phosphate-tributyl phosphate from nitric acid solutions. A synergistic effect was observed with a maximum at $C_{HNO_3} = 2M$. (M.C.G.)

15739 STUDY OF THE EXTRACTION OF PHOSPHORUS-ORGANIC COMPOUNDS BY NMR (NUCLEAR MAGNETIC RESONANCE) OF PHOSPHORUS AND HYDROGEN. Rozen, A. M.; Borodin, P. M.; Mitchenko, Yu. I.; Nikolotova, Z. I. Radiokhimiya; 12: 510-12(1970). (In Russian).

The chemical shifts of the NMR signals of ^{31}P of disolvates of uranyl chloride, sulfate, and nitrate with TBP, DAMP (diisopentyl methylphosphonate), and TOPO were measured; the proton spectra of these compounds were also obtained. It was established that the solvate chemical shifts of the NMR of ^{31}P are linear functions of the sum of the electronegativities of the substituent group (or the sum of the Taft constants) and decrease in the series of anions NO_3-Cl-SO_4, corresponding to the electronegativity. The logarithms of the extraction constant are linear functions of the solvate chemical shift of the NMR of ^{31}P. In the NMR spectra of ^{31}P from mixtures of solvates with extraction reagents, only one signal each is observed, which is evidence of rapid exchange of the molecules of the extraction reagent between the components of the investigated mixtures; the position of the signal is determined by the additivity law. It was shown that the measurement of the chemical shifts of the NMR signals of ^{31}P can be used to determine the content of metals in the organic phase. (auth)

15740 MECHANISM OF EXTRACTION OF TETRAVALENT CERIUM BY BIS(2-ETHYLHEXYL) PHOSPHATE FROM NITRATE SOLUTIONS. Mikhailichenko, A. I.; Volchenkova, N. G.; Pimenova, R. M. Radiokhimiya; 12: 466-71(1970). (In Russian).

The distribution coefficients in the extraction of tetravalent cerium by bis(2-ethylhexyl) phosphate (D2EHPA) from nitric acid solutions were determined. It was established that at 2 to 16M HNO_3, a compound with the composition $Ce(NO_3)_2A_2$, is extracted into the organic phase, where A is the anionic residue of D2EHPA. Hypotheses on the structure and nature of the bond of cerium in the extractable complex were advanced on the basis of data on the composition and infrared spectra. (auth)

15741 KINETICS OF EXTRACTION OF AMERICIUM(III) FROM PERCHLORIC ACID SOLUTIONS BY BIS(2-ETHYLHEXYL) PHOSPHATE IN DECANE. Karpacheva, S. M.; Ilozheva, L. V. Radiokhimiya; 12: 460-6(1970). (In Russian).

The kinetics of extraction of trivalent americium from perchloric acid solutions using bis(2-ethylhexyl) phosphate in n-decane in a system of intensive mixing was studied at the temperature $-3 \pm 0.2°C$. That the process takes place in the kinetic region is indicated by the activation energy, E = 12.7 kcal/mole. The reaction orders with respect to Am(III), D2EHPA, and H^+ ions were determined. The experimental data were treated considering re-extraction. The equation for the rate of the extraction process takes the form: $-(d[Am^{(III)}]/[dt]) = K([Am^{(III)}][D2EHPA]^{1.5}/[H^+]^2)$. A probable mechanism of the chemical reaction of extraction, satisfactorily corresponding to the experimental data, was proposed and discussed. It was shown that the limiting step of the process is the reaction, $AmX_2^+ + HX \rightarrow AmX_3 + H^+$, which most likely takes place in the aqueous phase. The values of the rate constant of the reaction at 25° and $\mu = 0.2$ and the values of the thermodynamic parameters of activation were calculated: K = $0.137 \pm 0.02 M^{0.5}$ sec^{-1}, $\Delta H^* = 12.1$ kcal/mole, $\Delta F^* = 16.3$ kcal/mole, and $\Delta S^* = -14.1$ eu. (auth)

15742 NEW METHOD FOR DESCRIBING THE DISTRIBUTION OF METAL IONS IN EXTRACTION SYSTEMS WITH MONOARYL- AND MONOALKYL-PHOSPHORIC ACIDS. Komarov, E. V.; Komarov, V. H.; Pushlenkov, M. F. Radiokhimiya; 12: 455-60(1970). (In Russian).

The quantitative principles of the extraction of metals with dibasic acryl and alkyl phosphates are discussed. It was shown that the generally accepted form of treatment of the experimental data does not reflect the complexity of the mechanism of the extraction of metals by strongly associated reagents. The equations obtained were confirmed by experimental data on the extraction of europium by solutions of MOPA (mono-n-octyl phosphate) in various solvents. (auth)

XUM

15743 ADSORPTION OF FREELY HYDROLYZABLE ELEMENTS ON SILICA GEL. I. THE ADSORPTION OF ZIRCONIUM AND HAFNIUM FROM SOLUTIONS OF MINERAL ACIDS. Tsaletka, R. Radiokhimiya; 12: 448-55(1970). (In Russian).

A study was made of the adsorption of zirconium and hafnium on silica gel as a function of the $HClO_4$, HNO_3, HCl, and H_2SO_4 concentrations. The results obtained can be explained from the standpoint of molecular adsorption of the hydrolysis products and neutral complexes with anions of the acids used as the electrolyte. The main factor influencing the adsorbability of the individual complexes is their hydration. A comparison of the relative strengths of the individual complexes was made on the basis of the data obtained. (auth)

15744 INVESTIGATION OF THE BEHAVIOR OF RADIOACTIVE ELEMENTS IN SORPTION SYSTEMS WITH HUMUS SUBSTANCES. II. SORPTION OF ^{91}Y BY ACTIVATED CHARCOAL FROM AQUEOUS SOLUTIONS IN THE PRESENCE OF HUMIC ACIDS. Shchetkovskii, V. N.; Khoroshailov, A. G. Radiokhimiya; 12: 442-7(1970). (In Russian).

As a result of an investigation of the sorption of ^{91}Y by iodide charcoal as a function of the Na_2SO_4 concentration at various pH values of the solutions, ion exchange and the colloidal character of the absorption of the radioactive isotope by the sorbent were investigated. An influence of humic acids on the magnitude and nature of yttrium sorption by charcoal was detected. In the presence of humic acids, a non-ion-exchange (colloidal) character of the sorption of ^{91}Y by the sorbents predominates. As a result of an investigation of the sorption of humic acids by charcoal, empirical functions were obtained, which relate the values of the sorption to the sodium sulfate concentration in solution, and an explanation was cited for the principles of sorption on the basis of a consideration of the nature and state of humus in solution. Some considerations on the existence of associates of ^{91}Y with micelles of humic acids were expressed on the basis of the change in the nature of the absorption of ^{91}Y by charcoal in the presence of these substances. (auth)

15745 COMMERCIAL LIGHT-WATER FUEL RECOVERY. Smith, C. Wesley; Bigge, William B. (General Electric Co., San Jose, Calif.). Proc. Amer. Power Conf.; 32: 286-94(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

Economics of fuel reprocessing, methods of reprocessing the BWR and PWR fuel, fuel recycle, and transportation are discussed. (M.C.G.)

15746 SEPARATION OF METAL COMPOUNDS FROM ORGANIC SOLVENT SOLUTIONS THEREOF. Gerfen, Charles D.; Ruhoff, John R. (to Mallinckrodt Chemical Works). British Patent 1,212,124. 11 Nov 1970. Filed 23 May 1968.

The process described involves steam distillation of the organic solvent in order to obtain a residue of aqueous soluble metal salt. It is illustrated with specific reference to Nb and Ta in the form of fluoro complexes in 4-methyl-2-pentanone solution. (UK)

15747 SEPARATING THORIUM FROM RARE EARTH METALS. Hansen, Robert Douglas (to Dow Chemical Co.). British Patent 1,219,305. 13 Jan 1971. Filed 21 Mar 1968.

An improved solvent extraction process is described for the separation of Th values from Y and rare earth values. The process is particularly suitable for the recovery of rare earths and Th from acidic aqueous solutions containing various metal impurities, including relatively large concentrations of ferric iron. The process described utilizes as extractant a mixture of a dialkyl substituted orthophosphoric acid and a trialkyl phosphate, dialkyl alkylphosphonate, alkyl dialkylphosphinate, or a trialkylphosphine oxide, each alkyl group having 4 to 18 C atoms. Stripping the organic phase with 6 to 12M HCl or 0.5 to 12M HNO_3 then gives a Th-rich organic phase and a rare earth rich aqueous phase. The organic extractant may comprise a mixture of di-(2-ethylhexyl) orthophosphoric acid (DEHPA) and TBP in kerosene. Details are given of suitable organic mixture compositions, pH, contacting period, and volume ratios. Examples of application of the process are presented. (UK)

15748 ELECTROLYTIC ISOLATION OF Pu(IV) FROM FORMIC ACID SOLUTIONS. Samartseva, A. G.; Zhuravleva, Z. A. At. Energ. (USSR); 29: 342-6(Nov 1970). (In Russian).

Experimental data on platinum cathode deposition of Pu(IV) from formic acid solutions are given. In order to establish the optimum conditions for plutonium electrodeposition, the dependence of its yield on hydrogen ion concentration and current density was studied. Appreciable deposition of plutonium begins at pH ≥ 1.8, and at pH ≥ 2.3 its yield attains 100%. During investigation into the dependence of plutonium deposition on the current density, a certain regularity was observed: the lower the electrolyte concentration, the lower current density is required for quantitative cathode deposition of plutonium. For electrolysis of Pu from 10^{-1} M solution of HCOOH the necessary current density is equal to 100 ma/cm^2 and from 10^{-3} M solution of HCOOH the current density is 10 to 15 ma/cm^2. The kinetics of Pu(IV) electrodeposition from formate solutions was investigated. It is shown that during the electrolysis of Pu from 10^{-1} M solutions of HCOOH its quantitative deposition finishes in 2 to 2.5 hours and from 10^{-3} M solutions of HCOOH, in 7 to 8 minutes. (auth)

15749 DEPOSITION OF METAL VALUES. Burkin, Alfred Richard. British Patent 1,215,574. 9 Dec 1970. Filed 24 Jan 1967.

Methods for recovering metal values from ores or wastes by solvent extraction techniques, using direct precipitation of the metals from the organic phase to provide a more direct and simplified process for their recovery are compared with conventional stripping techniques. The organic phase is contacted with a reducing gas, such as CO or H_2, for precipitation purposes, an acid acceptor such as ammonia or an amine being present if the metal species is more electropositive than Cd. The process employs a carboxylic acid extractant, containing 9 to 11 C atoms, and preferably a tertiary carboxylic acid. It may usefully be employed for Group Ib and VIII metals and for Fe, Co, Ni, Cd, V, U, Mo, or W. A suitable organic diluent for the carboxylic acid may be employed, such as an open chain hydrocarbon or a long chain alcohol, and a "seed" material may be used. The process is preferably carried out above 115°C and with a gas pressure above 200 lb/in^2. The "seed" material may comprise a fine metal powder, palladized C, colloidal graphite or other form of C dispersed in an organic medium. Examples of application of the process are given. The deposited metal value is usually the pure metal, but may be a compound, such as an oxide. (UK)

15750 PROCESS FOR RECOVERING URANIUM AS URANIUM DIOXIDE. Ishimori, Tomitaro; Ueno, Kaoru; Akatsu, Eiko; Kawasaki, Michiko (to Japan Atomic Energy Research Inst.). U. S. Patent 3,511,621. 12 May 1970. Priority date 3 Feb 1967, Japan.

Tri-n-butyl phosphate (TBP) containing uranyl nitrate complex was directly distilled. It was found that the distillation residue gives UO_2 upon ignition. (Offic. Gaz.)

15751 USE OF HIGH EFFICIENCY PACKED COLUMNS FOR GAS-SOLID CHROMATOGRAPHY. III. SEPARATION OF DEUTERIUM SUBSTITUTED COMPOUNDS. Di Corcia, Antonio; Fritz, Denes; Bruner, Fabrizio (Univ., Rome). J. Chromatogr.; 53: 135-41(2 Dec 1970).

Gas–solid chromatography with packed columns was used for the separation of some polar and nonpolar isotopic pairs; CH_3OH-CD_3OH, $C_2H_5OH-C_2D_5OH$, and CH_3CN-CD_3CN and $C_2H_6-C_2H_3D_3-C_2D_6$ and $C_2H_4-C_2D_4$. The method involves the use of graphitized carbon black modified with proper amounts of suitable liquid phases. A comparison with capillary columns showed that in many cases these can be conveniently substituted by packed columns. The method is useful either for the study of isotope effects or for analytical uses. (auth)

15752 GAS CHROMATOGRAPHIC ANALYSIS OF METAL PIVALOYLTRIFLUOROACETONATES. Tanikawa, Keiichi (Tokyo Research Inst.); Ochi, Hisao; Arakawa, Kiichi. Jap. Anal.; 19: 1669-72(Dec 1970). (In Japanese).

Various metal pivaloyl trifluoracetonates were synthesized and their mixtures were separated by gas chromatography. The recommended instrumental conditions were: a stainless steel column of 75 cm × 3 mmϕ, Chromosorb W and glass beads as the solid support, and Apiezon-L, Daifl oil 200 and silicone grease as the liquid phase. The amounts of coatings on the stationary phase were 5% on Chromosorb W (except for 3% on GF-1) and 0.5% on glass beads. Programmed temperature chromatography over the range of 120–150°C was successful for the separation of $Be(PTA)_2$, $Al(PTA)_3$, $Fe(PTA)_3$, $In(PTA)_3$ and $Cu(PTA)_2$, and that of 150–170°C for the separation of $Co(PTA)_2$, $Th(PTA)_4$ and the rare earth chelates. (auth)

15753 RADIOCHEMICAL METHODS OF ^{90}Sr DOSIMETRIC CONTROL IN CEREALS. Benes, J. (Inst. of Nuclear Research, Prague); Houstecka, I. Jad. Energ.; 16: 296-9(Sep 1970). (In Czech).

Six chemical separation methods for the determination of ^{90}Sr in cereals and other plant materials are evaluated. The yields and reproducibility of determinations and the effects of silicates on the ^{90}Sr determination are also treated. (auth)

15754 GOLD RECOVERY PROCESS. Hansen, Spenst M.; Snoeberger, David F. (to United States Atomic Energy Commis-

sion). U. S. Patent 3,545,964. 8 Dec 1970. Filed 18 Apr 1968.

A process wherein fragmented or comminuted gold ore (obtained by underground explosion of conventional or nuclear explosions) contacted with an acidic chloride leach liquor containing sodium azide, ethanolamine, ethylenediamine, or potassium thiocyanate as a covalent-bonding complexing agent in the presence of an oxidizing agent to leach gold from the ore is described. The leach liquor is circulated to a processing plant to recover the gold and the barren liquor is recycled. In the presence of such complexing agent greater proportions of the gold are leached and the leach liquor is stabilized against loss of the gold therefrom in the presence of ore thereby facilitating recovery of gold even from a low grade ore during long contact times. (Offic. Gaz.)

15755 ADSORPTION BEHAVIOR OF ^{66}Ge AND ^{68}Ga ON ALUMINA IN THE PRESENCE OF SOME CHELATING AGENTS. Sugii, Atsushi (Kumamoto Univ., Japan); Ogawa, Naotake; Kawamura, Shoichi. Jap. Anal.; 19: 1642-6(Dec 1970). (In Japanese).

Batch distribution coefficients, K_d, of ^{66}Ge and ^{68}Ga on various kinds of alumina were determined at various concentrations of several chelating agents including lactic acid, tartaric acid, citric acid, NTA, GEDTA, EDTA, DTPA, and CyDTA. EDTA, DTPA, and CyDTA were found to have favorable K_d values for the separation of the two radioactive nuclides. Although the K_d values of ^{66}Ge were generally high and independent of the pretreatment or of the kinds of alumina, those of ^{68}Ga were dependent greatly on the pretreatment and the adsorption characteristics of alumina. The K_d values of ^{68}Ga on the untreated or basic alumina were almost zero, regardless of the variation in the concentration of the chelating agents. However, the K_d values of ^{68}Ga on the hydrochloric acid-treated, acidic, or neutral alumina increased with a decrease of the concentration of chelating agents. The K_d values of both nuclides for DTPA or CyDTA solutions were similar to those for EDTA solution. It was found from the column chromatographic study that ^{68}Ga could be eluted in 20 ml of the eluate (5×10^{-3}M EDTA) from ^{66}Ge–^{68}Ga without any strict control of the elution rate. (auth)

15756 LIXIVIATION OF URANIUM ORES. GENERAL ASPECTS. APPLICATION OF PARTICULAR CASE. Despois, J. (CEA, Saint-Priest-La-Prugne, France). Rev. Ind. Minerale; 52: 736-44(Nov 1970). (In French).

Following a general account of lixiviation the sedimentary deposit of Grezieux-le-Fromental is described. The ore is poor and is formed of uranium ions fixed on clayey crystallites. Laboratory or field tests showed the possibility of recovering the metal by lixiviation with a sulfuric liquor. Tests preliminary to a lixiviation in situ are in progress on a clay-sand ore, but already the possibility of working on sub-surface (0 to 10 m) clays is being considered because of the anisotropy of the medium where permeability is concerned. The injection parameters were determined and a technology worked out. The first tests are promising. (auth) (France)

XUM

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 15518, 15549, 15805, 15806, 15881, 15959, 16066, 16083, 16156, and 16307.

15757 (AEC-tr-7214, pp 21-6) ACCUMULATION OF ARTIFICIAL RADIONUCLIDES ON THE EARTH'S SURFACE IN THE REGION OF LENINGRAD IN 1954 TO 1965. Gedeonov, L. I.; Gritchenko, Z. G.; Flegontov, V. M.; Zhilkina, M. I. Translation of A-AC-82/G/L-1171.

From USSR reports on radioactivity in man and the environment.

Data characterizing the accumulation of total fission products and individual radionuclides on the earth's surface in the vicinity of Leningrad during the period 1954 to 1965 are presented. It is shown that the cumulative activity of radionuclides which fell in the period of observation varied considerably, increasing with a certain delay after a series of tests and declining in the period of moratorium. An especially sharp decrease was noted in 1960, in January to August 1961, and in 1965. Long-lived radionuclides of ^{90}Sr and ^{137}Cs reacted less noticeably in the series of tests conducted before 1961, but the large release of those radionuclides in 1961 to 1962 caused a sharp increase in their accumulation on the earth's surface. By the end of 1965 the rate of accumulation of radionuclides with a half-life of 30 to 65 days (^{89}Sr, ^{91}Y, Zr + ^{95}Nb, ^{103}Ru, and ^{144}Ce) from explosions in 1961 to 1962 had declined to zero. The accumulation of ^{144}Ce + ^{144}Pr was 120 mCi/km^2; of ^{106}Ru, 41 mCi/km^2; of ^{90}Sr, 41 mCi/km^2, and of ^{137}Cs, 82 mCi/km^2. (auth)

15758 (AEC-tr-7214, pp 82-6) DISTRIBUTION OF ^{90}Sr AND ^{137}Cs IN THE PROFILE OF SOILS UNDER NATURAL CONDITIONS IN 1964. Rosyanov, S. P.; Vinogradova, V. K.; Gustova, L. I.; Gedeonov, L. I. Translation of A-AC-82/G/L-1169.

From USSR reports on radioactivity in man and the environment.

Data are presented on the vertical distribution of ^{137}Cs and ^{90}Sr in various soils in the USSR during 1964. Soil samples were taken to depths up to 30 cm. Determination of the ^{90}Sr content was carried out by radiochemical analysis, while the ^{137}Cs content was determined by the gamma spectrometric method. It was concluded that the vertical distribution of radioactive fission products in soils is determined by the chemical and physical properties of the radioisotopes and the occurrence of numerous migration processes. The efficiency of these processes depends primarily on the basic factors of soil formation such as the source rock, climate, topography, vegetation, etc. (L.C.L.)

15759 (AEC-tr-7214, pp 143-60) DISTRIBUTION OF RADIOACTIVE STRONTIUM IN THE SOILS OF DIFFERENT NATURAL ZONES. Tyuryukanova, E. B.; Pavlotskaya, F. I.; Baranov, V. I. Translation of A-AC-82/G/L-1176.

From USSR reports on radioactivity in man and the environment.

The distribution of ^{90}Sr in various soils in the USSR was studied to ascertain the zones of concentration and scattering and the possibility of using this radioisotope in the analysis of recent soil forming processes. Depths to 130 cm were investigated, although most of the data is for measurements to less than 70 cm. The soil types were classified as sod, sandy loam, clay, humus, peat, cropland, forest, and flood plain. It was concluded that: the ^{90}Sr distribution in the soil mantle is largely determined by geomorphological and hydrometeorological conditions; ^{90}Sr is held most firmly in soils with high humus content; the lack of correspondence in the behavior of stable and radioactive strontium in years with considerable fallout levels can be explained by the different sources the forms of their entry into the soil, and their reaction times with it; and the vertical migration of ^{90}Sr depends on the genetic structure of the soils, i.e., ^{90}Sr is delayed in humus horizons, washed away in podzonic horizons, and retained in illuvial horizons. (L.C.L.)

15760 (AEC-tr-7214, pp 161-86) ^{90}Sr IN FRESH AND BRACKISH BODIES OF WATER. Polikarpov, G. G.; Parchevskii, V. P.; Timoshuk, V. I.; (and others). Translation of A-AC-82/G/L-1178.

From USSR reports on radioactivity in man and the environment.

The content of radioactive and stable Sr in waters from the Sea of Azov(USSR) was measured during 1966, and the distribution of stable Sr in the Sea of Azov was compared with the distribution of ^{90}Sr during the same period in the Caspian Sea, Lake Gusenu, Lake Rushony, and the Sea of Azov in order to ascertain general and specific features of Sr distribution in water areas containing fresh and brackish water. The characteristics of each body of water and the sampling and analysis methods used are described. The accumulation of ^{90}Sr in lake plankton was also investigated. It was concluded that: during 1966 there was little, if any, variation in the ^{90}Sr concentrations in brackish and fresh water basins at different locations; the ^{90}Sr distribution within a given body of water depends on the complexity of hydrological conditions affecting that body of water; in the Sea of Azov the distribution of stable Sr correlates with the salinity; the ^{90}Sr content of the lakes has not decreased for several years prior to 1966; and hydrobionts (plankton) can be used as radioecological indicators of the degree of ^{90}Sr contamination in water basins. (L.C.L.)

15761 (JINR-P6-5307) INVESTIGATION OF WEAK RADIOACTIVITIES OF LEAD-ZINC ORES VOLATILE FRACTION BY MEANS OF α-X COINCIDENCE METHOD. Kusch, W.; Chepigin, V. I.; Ter-akopyan, G. M.; Bogdanov, S. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1970. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

Theoretical calculations were published previously in which the possibility of existence of long-lived nuclei with Z = 110 to 114 was discussed, and focused the interest on the unidentified low activities of rocks and minerals. A method of $\alpha - x$ coincidence was employed to establish an atomic number of low alpha emitters. The alpha activity of volatile fractions of lead-zinc was investigated. It was shown that in the fraction, ^{237}Np probably of technogenic origin, is present. (auth)

15762 (LA-4561) PLUTONIUM IN STREAM CHANNEL ALLUVIUM IN THE LOS ALAMOS AREA, NEW MEXICO. Purtymun, William D. (Los Alamos Scientific Lab., N. Mex.). Nov 1970. Contract W-7405-eng-36. 7p. Dep. NTIS.

A survey of plutonium isotopes ^{238}Pu and ^{239}Pu in the alluvium of major canyons in the Los Alamos Area was made to determine concentrations and movement of soil-bound plutonium. Trace concentrations of plutonium were found in alluvium in those canyons which have received or are receiving treated effluents from operations of the laboratory. The concentrations of plutonium in the alluvium of the remainder of the canyons were no greater than those concentrations attributed to world-wide fallout from atmospheric tests. (auth)

15763 (LA-4562) PLUTONIUM AND STRONTIUM IN SOIL IN THE LOS ALAMOS, ESPANOLA, AND SANTA FE, NEW MEXICO, AREAS. Kennedy, William R.; Purtymun, William D. (Los Alamos Scientific Lab., N. Mex.). Nov 1970. Contract W-7405-eng-36. 4p. Dep. NTIS.

Analyses for plutonium isotopes ^{238}Pu and ^{239}Pu and strontium isotope ^{90}Sr were made of soil samples collected from the Los Alamos, Espanola, and Santa Fe areas to determine concentration levels considered as originating from worldwide fallout from atmospheric tests. On the basis of the limited number of samples it was concluded that the concentrations in soils from the area of study were similar to but no greater than those reported by others for soil samples from Colorado, Ohio, and New York. (auth)

15764 (ORO-678, pp 124-5) DIFFUSION IN NON-IDEAL SYSTEMS. Spalding, Gary E. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1-December 31, 1969.

The role of diffusion in the movement of fission products through soils and their subsequent uptake by plants was studied in order to develop adequate theoretical means for predicting the contribution of diffusion to the total transport of fission products through soils. Progress is reported on plant studies to evaluate the effectiveness, efficiency, and specificity of various mutagenic treatments and to gain information on the control and modification of seed radiosensitivity. (L.C.L.)

15765 USE OF NATURAL TRITIUM IN HYDROGEOLOGICAL STUDIES. Romanov, V. V.; Soifer, V. N. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 4, 289-304(1968). (In Russian).

A method for accurately predicting the average level of natural tritium in atmospheric precipitation in practically any geographic zone is presented, and the uses of these tritium concentration values in hydrogeologic studies, particularly for estimating the dynamics and resources of groundwater, are discussed. (tr-auth)

15766 MIDDLE DEVONIAN DEPOSITS OF THE LOWER VOLGA REGION TAKEN AS AN EXAMPLE FOR THE PALEOSTRUCTURAL RECONSTRUCTION BY USING NATURAL RADIOACTIVITY. Ryabchikov, V. I.; Kucheruk, E. V. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 4, 246-54(1968). (In Russian).

A gamma well logging method is discussed which permits determination of the lithology of boreholes and a reconstruction of the sedimentation processes which occurred at a particular location. Use of the method in the middle Devonian deposits of the lower Volga region is described. (tr-auth)

15767 RELATION OF THE MEAN LIFETIME OF THERMAL NEUTRONS TO THE MINERAL DENSITY IN ROCKS. Srebrodol'skii, D. M. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 3, 124-7(1968). (In Russian).

The relation between the average lifetime of thermal neutrons and the mineral density in rocks was studied. It was found that thermal neutron average lifetime measurements could be used to differentiate between the physical properties of the host rock and its mineralization and that the method permitted qualitative estimation of the density and porosity of the water-bearing layers in the rock. Moreover, the higher the mineralization of the stratum water, the more accurate this estimation method is. (tr-auth)

15768 DISTRIBUTION AND PROSPECTING CRITERIA FOR RADIOACTIVE ELEMENTS AND GAMMA FIELDS IN OIL-BEARING AREAS. Alekseev, F. A.; Gottikh, R. P.; Vorob'eva, V. Ya. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 4, 196-222(1968). (In Russian).

The accumulation of organic substances in the process of sedimentation leads to significant uranium enrichment of rocks. The content of radioactive elements in soils is determined by the composition of the soils and the soil-forming rocks. For rocks and soils of one mineral composition there is an observed correlation between the radioactivity and the organic material content. A study of the natural radioactivity of mineral rocks resulted in the following conclusions: measurement of the distribution of intensity of natural gamma radiation on the earth's surface can be used to detect gas- and oil-bearing structures; gamma borehole data can be used to study the tectonic development and clay quality of rocks in a particular geologic area; and the radiometric method can be used for studying conditions of deposit accumulation in gas- and oil-bearing areas. (tr-auth)

15769 EFFECTS OF SNOW ON SOIL WATER MEASUREMENT BY NEUTRON MODERATION. Vredenburg, R. T.; Willis, W. O. (Dept. of Agriculture, Mandan, N. Dak.). Can. J. Soil Sci.; 50: 463-4(Oct 1970).

The effects of snow on measurement of the soil water content of the surface 30 cm of soil are reported. Field experimentation was conducted on Grail silt loam and Parshall fine sandy loam. On each soil, treatments were established by manually removing the snow to desired depths and diameters. Depth of snow cover was 69 cm with a water content of 9.7 cm. Neutron moisture readings were taken with the neutron source at 5, 10, 15, and 20 cm below the soil surface. Results show that when soil water measurements under winter conditions are taken by neutron moderation from in-place access tubes, the operator is advised to remove the snow cover (or otherwise account for effects) prior to taking readings. (J.R.D.)

15770 SEARCH FOR REMOTE TRANSURANIUM ELEMENTS IN IRON-MANGANESE NODULES. Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol.; A38: 595-601(Nov 1970). (In Russian).

Effects of fission of remote transuranium elements were studied in iron–manganese nodules extracted from the bottom of the southern region of the Pacific Ocean. A large number of fission tracks (from 7 to 120 tracks/mm^2) were found in the mineral nodules of the feldspar group. The results of analysis showed that spontaneous uranium fission was responsible for only 10 to 20% of the observed tracks. It was postulated that the rest of the tracks were the result of the spontaneous fission of remote transuranium elements of the earth or cosmic origin, found in the nodules. (R.V.J.)

15771 TREE RING, VARVE, AND ^{14}C CHRONOLOGIES. Stuiver, M. (Univ. of Washington, Seattle). Nature (London); 228: 454-4(31 Oct 1970).

Possible deviations between radiocarbon and actual ages were considered; conventional radiocarbon ages do not allow for deviations in atmospheric ^{14}C content during the past, and as a result radiocarbon years may not always be equal to solar years. Dendrochronologically dated tree rings were considered the most suitable means for precise determinations of atmospheric ^{14}C variations during the past. There appear to be both long- and short-term variations in the ^{14}C concentration of wood samples. The short-term oscillations were of about one to two hundred year periods and correlated significantly with the solar cycle modulation of the cosmic ray flux. The most recent data for long-term variation of atmospheric ^{14}C obtained from tree ring data are shown graphically. The time span of the tree ring chronology (at present 7,400 yr) is unlikely to be extended by more than a few thousand years because of the lack of suitable specimens, but varve series appear to be a suitable alternative for extension of the study of ^{14}C variations, and the results for two varve series were also shown graphically and discussed. It was concluded that, in general, ^{14}C dates corresponding with 5,000 to 7,400 solar yrs were 600 to 800 years too young, and a similar error was indicated for the 7,400 to 10,000 varve year interval. (UK)

15772 EFFECT OF CONCENTRATION ON THE IODIDE SORPTION BY VARIOUS SOILS. Knaelmann, M. (Technische Hochschule, Hanover). Atomkernenergie; 16: 247-52(1970). (In German).

Among the fission products, iodine-131 is relatively easily transported in the soil. Therefore its uncontrolled spreading in the soil constitutes a hazard. The sorption of iodine by 59 different soils was therefore investigated. Iodine was supplied in form of aqueous iodide solutions of different concentrations. Differences in the relative sorption were noted among the various soils; however, the plot of concentration supplied versus relative sorption gave similar shaped curves for all soils. (auth)

15773 METHOD TO DETERMINE THE ABSORBED DOSE OF NATURAL RADIOACTIVITY IN UNDERGROUND WATERS. Vovk, I. F. (Kiev State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 10, 881-3(Oct 1970). (In Ukrainian).

A calculation method is suggested for the determination of the absorbed dose of natural radioactivity in underground waters. Data on the content of radioactive elements in rocks where underground waters move and on filtration parameters of rocks or the content of radium and radon in underground waters are employed. (auth)

15774 MECHANISM OF EMANATION FROM RADIOACTIVE MINERALS AND ORES. Shashkin, V. L.; Prutkina, M. I. At. Energ. (USSR); 29: 41-2(Jul 1970). (In Russian).

The radon emanation coefficient from ores and minerals was greater in liquid than in air. The emanation coefficient in liquid was higher, the better the liquid wet the surface of the capillaries. After drying a sample of raw material to a 5 to 10% moisture content, the emanation coefficient remained the same as during emanation into water. The actinon emanation into water was also greater than into air (by a factor of 1.5 to 1.7 for pitchblende). The ratio of emanation coefficients in air and water increased with decreasing particle size. Preliminary calcination of the sample at temperatures of 100 to 600°C led to a sharp decrease in the emanation coefficient with a subsequent rise after storage for a period of time under normal conditions or after wetting. It is believed that the retention of radon and actinon is associated with the presence of a film of capillary water. (TTT)

15775 DEVELOPMENT PROPERTIES OF FISSION FRAGMENT TRACKS IN NATURAL MICA. Hassib, G. M.; Gomaa, M. A. (Atomic Energy Establishment, Cairo). Health Phys.; 19: 325-6(Aug 1970).

The etching phenomena, using hydrofluoric acid as the etching agent for the spontaneous fission tracks in natural mica, were investigated. Results showed that track length increased linearly with etching time. These results were used for deriving the functional relationship between the rate of track growth etching speed and the acid concentration or acid temperature. (auth) (UK)

Meteorology

Refer also to abstracts 15514, 15763, 15806, 16063–16065, 16067–16070, 16078, 16080, 16114, 16127, 16170, 16179, and 17252.

15776 (AEC-tr-7214) USSR REPORTS ON RADIOACTIVITY IN MAN AND THE ENVIRONMENT. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 308p. Dep. NTIS.

Separate abstracts were prepared on 20 sections of this report. (C.H.)

For abstracts of individual sections see: 15471, 15757–15760, 15777–15780, 15799, 15800, 16063–16070, and 16127.

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15777 (AEC-tr-7214, pp 9-20) LEVELS OF RADIOACTIVE CONTAMINATION OF SURFACE AIR AND THE SURFACE OF THE EARTH BY FISSION PRODUCTS IN 1963 TO 1965 IN THE VICINITY OF MOSCOW. Brendakov, V. F.; Davydov, E. N.; Gaziev, Ya. I.; (and others). Translation of A-AC-82/G/L-1201.

From USSR reports on radioactivity in man and the environment.

Data on systematic measurements of the concentrations of fission product aerosols in the surface layer of the atmosphere, their fallout from the atmosphere, and their content in the upper layer of the soil (0 to 10 cm) in the vicinity of Moscow from 1963 to 1966 are presented. (auth)

15778 (AEC-tr-7214, pp 51-61) ARTIFICIAL RADIOACTIVITY OF ATMOSPHERIC AEROSOLS. Gedeonov, L. I.; Gritchenko, Z. G.; Zhilkina, M. I.; Flegontov, V. M. Translation of A-AC-82/G/L-1166.

From USSR reports on radioactivity in man and the environment.

Experimental data are presented which characterize the variation of the specific radioactivity of atmospheric dust collected by precipitation and by filtration of air through a FPP-15 filter in the vicinity of Leningrad from 1959 to 1966. The investigation showed that the role of the secondary component of radioactive fallout and the contamination of the atmosphere by other long-lived fission products are small and do not exceed 0.3 to 0.5% of the annual radioactive fallout. It was found that the main source of global fallout and contamination of atmospheric dust by long-lived fission products is the stratospheric reservoir from nuclear tests. (auth)

15779 (AEC-tr-7214, pp 62-9) DETERMINATION OF ^{109}Cd IN SURFACE AIR AND FALLOUT IN SOME PLACES OF SOVIET UNION IN 1964 TO 1965. Federov, G. A.; Konstantinov, I. E.; Scotnikova, O. G.; Malakhov, S. G. Translation of A-AC-82/G/L-1196.

From USSR reports on radioactivity in man and the environment.

In 1964 to 66 the levels of fallout from high-altitude tracer ^{109}Cd are studied at three regions of Soviet Union. Collections of precipitation were made by means of stainless steel tanks with collection areas of 0.75 m^2 and wall heights of 0.5 m. After chemical separation and purification of ^{109}Cd, the measurement of activity was carried out by the 22 to 25 keV x-ray photopeak of ^{109}Cd + ^{109m}Ag on the 2π γ-spectrometer. A NaI(Tl) crystal (height 2 mm dia. 45 mm) and a photomultiplier was used as a detector. Obtained levels of fallout of ^{109}Cd agree with data predicted by H. L. Volchok on the basis of the ^{102}Rh tracer experience to an accuracy of about 50%. (auth)

15780 (AEC-tr-7214, pp 267-93) COMPARISON OF THE RESULTS OF MEASUREMENTS OF ATMOSPHERIC FALLOUT OF ^{90}Sr IN VARIOUS COUNTRIES. Pudovkina, I. B. Translation of A-AC-82/G/L-1202.

From USSR reports on radioactivity in man and the environment.

A comparison is presented of the mean characteristics of the fallout of ^{90}Sr obtained in various countries within the confines of the same latitudes and ranges of precipitation measured. It was concluded that a satisfactory agreement between data is observed for monthly fallout of ^{90}Sr amounting to less than 1.0 μCi/km^2. For higher fallout levels the measurement data of the other countries are found to cite consistently higher figures (by about 20%) than the network of the Health and Safety Laboratory, United States Atomic Energy Commission. It is shown that this discrepancy may be attributed to the differences in the methods of fallout collection employed by the network of the Health and Safety Laboratory, and the networks of the other countries. (auth)

15781 (HASL-239) FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, SEPTEMBER 1-DECEMBER 1, 1970. Hardy, Edward P. Jr. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Jan 1971. 283p. Dep NTIS.

The quarterly summary report for the Health and Safety Laboratory Fallout Program is presented. A separate abstract was prepared for each of the eight sections. (L.C.L.)

For abstracts of individual sections see: 15513, 15514, 15782-15785, 16114, and 16133.

15782 (HASL-239, pp I,2-22) OCEAN FALLOUT: THE BAHAMA BANKS EXPERIMENT II. Volchok, H. L. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

From Fallout Program quarterly summary report, September 1-December 1, 1970.

Three years of continuous sampling of fallout and seawater at a fixed platform in the shallow waters of the Great Bahama Bank has shown that although the annual precipitation is quite low the concentration of ^{90}Sr is typical of other sites in the latitude band. Probably due to local meteorological effects, the water on the bank stagnates for about the first half of each year, thereby integrating the deposited fallout. However, the monthly ^{90}Sr fallout was not sufficient to account for the seawater concentrations, suggesting another, at this time, unknown source. (auth)

15783 (HASL-239, pp I,63-79) SEASONAL AND LATITUDINAL MODIFICATION OF THE HASL MODEL OF ATMOSPHERIC TRANSPORT. Krajewski, Barbara; Krey, Philip W. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

From Fallout Program quarterly summary report, September 1-December 1, 1970.

The HASL Model of Atmospheric Transport (Box Model) which generated annual estimates of nuclear weapon fallout is modified to predict deposition and surface air concentrations on a monthly basis and in 10° latitude increments. These modifications were derived from the fallout patterns of the 1961-1962 test series. The seasonally adjusted model reasonably predicted the monthly surface air concentrations and deposition from the large Chinese tests in 1967 and 1968 and from the large French tests in 1968. (auth)

15784 (HASL-239, pp I,80-91) UPDATING STRATOSPHERIC INVENTORIES TO JANUARY 1970. Krey, P.; Krajewski, B. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

From Fallout Program quarterly summary report, September 1-December 1, 1970.

Stratospheric inventories of ^{90}Sr and ^{95}Zr are updated to January 1970. It is estimated that the Chinese test of September 29, 1969 injected about 150 kCi of ^{90}Sr into the stratosphere. The approximate fission and total yields of significant nuclear weapons tests conducted in the atmosphere since 1962 through the end of 1969 are presented and are in general agreement with the HASL stratospheric inventories of ^{90}Sr since 1967. (auth)

15785 (HASL-239, pp III,40-4) PROTECTION SERVICE, SITE SURVEY AND METEOROLOGY SECTION QUARTERLY REPORT. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

From Fallout Program quarterly summary report, September 1-December 1, 1970.

The results of monitoring the ground-level atmosphere and atmospheric precipitation at Ispra, Italy for gross beta activity and fallout content during July to Oct. 1970 are presented. (L.C.L.)

15786 (PNE-327) OFF-SITE ENVIRONMENTAL SURVEILLANCE: PROJECT BUGGY I. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Sep 1970. 128p. Dep. NTIS.

The Southwestern Radiological Health Laboratory (SWRHL) provided off-site radiological surveillance support for Project Buggy I, conducted at the Nevada Test Site (NTS) at 0904 PST on March 12, 1968. The radioactive effluent released from this event traveled northward from the NTS and was detected in the environment as far north as Montana. The highest exposure rate observed off-site was 8.5 mR/hr measured during cloud passage at an unpopulated location approximately 80 miles from the point of detonation. The highest integrated exposure observed in the off-site area, as measured by thermoluminescent dosimeters, was 11.3 mR in the same unpopulated area. Thermoluminescent dosimeters located at populated areas indicated no external radiation exposures above background. These dosimeters were placed prior to the detonation to document the external radiation exposure from cloud passage plus 8 days of residual activity. The highest concentration of ^{131}I in milk was 550 pCi/l in samples collected near Wells, Nevada on March 15 and 16. The second highest concentration of ^{131}I in milk was 100 pCi/l in a sample collected near Eureka, Nevada on March 15. The highest time-integrated gross beta activity in air at a populated location was 59,000 pCi-hr/m^3 collected at Warm Springs on March 12. (auth)

15787 DETECTION OF FRESH FISSION PRODUCTS ABOVE YUGOSLAVIA AFTER THE 6th AND THE 7th NUCLEAR TEST EXPLOSION IN THE PEOPLES REPUBLIC OF CHINA. Picer, Mladen. Nukl. Energ.; 4: No. 6, 32-5(1967). (In Serbo-Croatian).

The autoradiographic method for detection of radioisotopes collected on filter papers is described. The results of the measurements of the total beta radioactivity of the samples from Zadar and Zagreb are given, while only the total beta radioactivity of the samples from Ljubljana, Jezersko, Ajdovščina, Skopje, Gevgelija and Sarajevo during the following periods from June 25 till July 25, 1967, and from January 1 to 3, 1968, are tabulated after the nuclear test explosions conducted in the Peoples Republic of China in mid-June and the end of December 1967. A discussion is given on the reproducibility of the autoradiography method and of the factors effecting its reproducibility. (auth)

15788 WORKING PRINCIPLES OF THREE-DIMENSION GAMMA-RAY CONTAMINATION SIMULATOR FOR RADIOACTIVE FALLOUT. Vojvodic, Vlaho. Nukl. Energ.; 4: No. 6, 28-31 (1967). (In Serbo-Croatian).

The principle is described for the simulation of three dimension gamma radiation with moving point sources. A schematic description is given of one possible system where the point source is hydraulically moved. It was shown that the simulation of gamma radiation in radioactive fallout could be achieved with commercially available ^{60}Co. Some technical issues to be taken into account when measuring the factors of protection are described. (auth)

15789 ENVIRONMENTAL MONITORING OUTSIDE ATOMIC ENERGY INSTALLATIONS. 1. MONITORING BY THE MEASUREMENT OF γ-RAY IN AIR. Okano, Masaharu (Inst. of Physical and Chemical Research, Yamato, Japan). Hoken Butsuri; 5: No. 2, 81-7(Jun 1970). (In Japanese).

The environmental monitoring in the areas surrounding atomic energy installations by the measurement of γ-rays in the air is discussed. The purpose of the monitoring by the measurement of γ-rays in the air is the measurement of personnel γ-ray exposure, to find out the behavior of environmental radioactivity for the safe operation of atomic energy installations. Environmental radiation is broadly divided into cosmic-ray and environmental γ radiation. The environmental γ-radiation comes mostly from the radioactive material which exists in the environment. Some important properties of environmental radiation are described in relation to environmental monitoring. Ionization chambers, gas discharge tubes, solid, and liquid detectors, emulsion, TLD, and activated glass are used for the measurement of γ radiation in the air. Spectrometers for the continuous monitoring of radiation, and ionization chambers are described in relation to the measurement of γ-radiation in the air. (Japan)

15790 ENVIRONMENTAL MONITORING OUTSIDE ATOMIC ENERGY INSTALLATIONS. 2. MONITORING BY MEASUREMENT OF ACTIVITIES IN ENVIRONMENTAL MATERIALS. Kasai, Atushi (Japan Atomic Energy Research Inst., Tokai). Hoken Butsuri; 5: No. 2, 89-95(Jun 1970). (In Japanese).

Monitoring by the measurement of the radioactivity of environmental material is discussed. Thorough monitoring by this method is possible by the measurement of γ radiation in the air. The principle of environmental monitoring is to monitor only the definite critical nuclide, critical pathway, and critical group. The monitoring plan described includes monitoring before operation, namely background survey, and monitoring after operation. Background survey and the choice of samples are explained. The measurement of samples is broadly divided into the measurement of total β activity and nuclide analysis. The standard value or level for environmental monitoring is determined, and a search for causes is started when the level is surpassed. (Japan)

15791 TEMPORAL DISTRIBUTIONS OF RADIOACTIVITY AND $^{89}Sr/^{90}Sr$ RATIOS DURING RAINSTORMS. Noyce, J. R.; Chen, T. S.; Moore, D. T.; Beck, J. N.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Contract AT(40-1)-2529. J. Geophys. Res.; 76: 646-56(20 Jan 1971).

Radionuclide concentrations for ^{89}Sr, ^{90}Sr, ^{144}Ce, and ^{137}Cs were sequentially sampled from two rainstorms to study fallout behavior as a function of rainfall rate and type of storm approximately 7 months after the eighth Chinese nuclear explosion of December 27, 1968. Great time variability in the $^{89}Sr/^{90}Sr$ ratio was found in conjunction with a well-developed storm on July 21, but a nearly steady ratio was observed in a stratified stable-type storm on August 14. Tapping of stratospheric air appeared to be the cause of the ratio changes. For both storms, a strong trend was found for concentrations of radioisotopes to decrease with increase in rainfall rate. Detailed discussions on meteorological factors, including a dilution effect, are given to interpret the experimental data. (auth)

15792 DEVELOPMENT OF URANIUM MINE RESEARCH LABORATORY. Kaufman, Edward L.; Dinwiddie, Robert E. (New Mexico Health and Social Services Dept., Santa Fe). Health Phys.; 20: 94-7(Jan 1971).

Project Dakota was a former uranium-producing mine that was converted to a laboratory for the research of ways to control radon and radon daughters in underground mine atmospheres, together with other investigations related to the protection and the health of all underground miners. Drilling, blasting, slushing, and other everyday operations may be done in the Dakota, but the various parameters may be controlled in a way that is impossible in an operating mine. Details of the installations, buildings and facilities are given. This facility is available on a no-cost basis to any agency, company, university, or interested responsible parties for the conduct of research or tests which will lead to practical solutions to the problems of control, measurement, or exposure of persons to radon and radon daughters. (UK)

15793 COMMENTS ON A PAPER BY M. BERAN AND G. ASSAF, USE OF ISOTOPIC DECAY RATES IN TURBULENT DISPERSION STUDIES. Okubo, Akira (Johns Hopkins Univ., Baltimore). J. Geophys. Res.; 76: 753-4(20 Jan 1971).

Comments are given on a paper published previously concerning the use of isotopic decay rates in turbulent dispersion studies. The paper was abstracted in NSA as 24: 46369. (G.M.C.)

15794 DETECTION OF RADIOTUNGSTEN IN RAINWATER. Mamuro, T.; Matsunami, T.; Ishiyama, T. (Radiation Center of Osaka Prefecture). Health Phys.; 20: 86-9(Jan 1971).

Gamma ray measurements were carried out on rainwater from mid 1968 to mid 1969 to detect the delay between the French nuclear explosions of 1968 and the appearance of fresh debris at Osaka. This was found to be 45 days. Similar data were also obtained for the USSR test of Nov 7 (9 to 13 days), the USA test of Dec 8 (10 to 16 days) and the Chinese Test of Dec 27 (9 days). The concentrations of ^{181}W in rainwater samples collected between Dec 18, 1968 and Jan 21, 1969 are tabulated. On one sample using β ray spectrometry following chemical treatment, the activity ratio of the tungsten radioisotopes ^{181}W : ^{185}W : ^{188}W, converted to the time of detonation (Dec 8 1968) was roughly estimated to be 1 : 1.6 : 0.5. The considerable difference in this ratio to that applicable to tungsten after neutron irradiation in a reactor is discussed. (UK)

Mineralogy and Exploration

Refer also to abstract 15756.

15795 (CEA-R-4003) CRYSTAL CHEMISTRY OF THE URANIFEROUS PHOSPHATE IN BAKOUMA DEPOSITS (CENTRAFRICAN REPUBLIC). Gony, Jean-Noel (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jan 1971. 108p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Nancy, France.

The crystal mineralogy and chemistry of the uraniferous phosphate found at Bakouma were studied in order to deduce modalities occurring in the fixation and distribution of uranium. The mineralogical composition of the ore was studied by x-ray-diffraction, the distribution of major and minor constituting elements investigated with a microprobe and the dispersion of radioactivity determined by autoradiography. An affinity between uranium and apatite was found. A detailed study of the crystal chemistry of apatite, using x-ray-diffraction, infrared spectroscopy, and analytical chemistry, was then made and the degree of oxidation of the uranium determined by polarography. Results show that apatite favors the fixation of U(IV) in the lattice and U(VI) at the surface; this change and the recrystallization account for the oxidation of uraniferous minerals. Apatite is geochemically important in the history of the deposit. (auth) (France)

15796 (GJO-918-5) FIRST GENERATION SIMULATION MODEL FOR SELECTING AMONG EXPLORATION PROGRAMS; WITH SPECIAL APPLICATION TO THE SEARCH FOR URANIUM ORE BODIES. Final Report, Part 3. Griffiths, John C.; Singer, Donald A. (Grand Junction Office (AEC), Colo.). Sep 1970. Contract AT(05-1)-918. 121p. Dep. NTIS.

With appendix on an alternate model by James B. Bartoo.

The philosophy of search is discussed and some of the basic fundamentals of importance in the exploration for non-renewable natural resources are emphasized; these principles lead to definition of the problem as an exceedingly complex probabilistic problem. A review of search theory, as an area of activity in the broader context of operations research, leads to formulation of a black box model; simulations by means of this model are used to represent exploration for uranium ore bodies. The Engel Model, considered as a first generation simulation model, is then described; to simulate by means of this model requires estimates of twelve interdependent parameters which enter the model as input. An algorithm encompassing the model is then programmed for a computer and the output may be expressed in terms of profitability. Relatively firm estimates of some of the parameters exist for uranium exploration in the Ambrosia Lake region of New Mexico and the Shirley and Gas Hills basins in Wyoming. Ranges, for those estimators of parameters which were not known, were included in sets of simulations and the sensitivity of the parameters was then determined. The Ambrosia Lake situation encompassed a large number of prizes of average value and maximum profit outcomes were determined by simulation. In the Wyoming basin situation there were four large prizes and again,

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maximum profit outcomes were located by simulation. In both cases the most sensitive parameters were the detection or sensor system characteristics; in order to achieve more precise definition of the maximum-profit program firm estimates of these parameters are essential. The most favorable program for searching for many prizes of average value differs from the search for a few large and valuable prizes essentially in the relative importance of these sensor system-terrain characteristics. In the former case the area of influence of the detection system, a drilled well in these simulations, was most important; whereas, the probability of false signals, i.e., the noise level, was more important in the search for a few large prizes. Suggestions for modification of the first generation model to develop second and third generation, more sophisticated, models are also briefly discussed. In connection with future research along these lines an alternate model based on different assumptions is also proposed. (auth)

15797 NEW TECHNIQUE FOR INVESTIGATING RADIOMETRIC CONTRAST IN MINED URANIUM ORES. Hejtman, J. Rudy (Prague); 18: 216-21(Jun 1970). (In Czech).

Problems of radiometric contrast are dealt with and a critical evaluation of the techniques used to investigate radiometric contrast in mined uranium ores is given. A new technique is proposed, based on a consistent application of the principle that radiometric separation on separators which lack correction devices does not depend on metal content or uranium content of individual grains but on the observed pulse rate caused by γ-quanta emitted by the grains. Standard γ-radiation sources were used to ensure comparability and reproducibility of measurements performed on different devices. The new technique was tested on mined ores from Czechoslovak uranium deposits. Results of an investigation of radiometric contrast in an ore with granularity +40 to 60 mm are given. (INIS)

15798 ORIGIN AND DEPOSITIONAL ENVIRONMENT OF URANIUM DEPOSITS OF THE GRANTS REGION, NEW MEXICO. Squyres, John Benjamin. Stanford, Calif.; Stanford Univ. (1970). 242p. University Microfilms Order No. 70-22,205. Thesis.

The uranium deposits of the Grants Region, New Mexico, are described and the various ideas concerning the deposits, and attempts to synthesize a systematic account of their age, origin, and history reviewed. Particular attention was paid to environmental conditions during the depositional process. The ore deposits of the Grants Region occurred mostly in sandstones in the upper part of the Jurassic Morrison Formation. The sandstones were arkosic, of fluvial origin, and contained abundant volcanic detritus, now largely altered to clay minerals. The primary ore deposits form pods or blanket-like masses, elongated parallel to the channel deposits in which they occurred, and consisted of microscopic uranium and vanadium minerals in a matrix of dark-colored organic matter which impregnated the sandstone. Molybdenum sulfide formed irregular masses around the edges of the orebodies. Arsenic and selenium tended to be concentrated at the ore boundaries. Away from the ore the sandstones were light colored and pyritic, except where affected by postore oxidation. The associated claystone and mudstone beds were generally light green. The uranium deposits were formed shortly after the deposition of their host rocks, at temperatures and pressures normal at the earth's surface, in an environment of unconsolidated sediments saturated with alkaline ground water moving in the same direction as the surface flow. The ore and accessory elements were derived chiefly from volcanic detritus in the sediments. Volcanic ash also helped maintain the alkaline condition of the ground water. The organic matter in the orebodies was leached from plant matter buried with the sediments, then flocculated, consolidated, and moulded by the ground water into the stream-lined lobate forms typical of the primary orebodies. The ore elements were not transported with the organic matter, but began to accumulate as soon as the humate masses were formed. Uranium was precipitated by the humates through adsorption and reduction. Vanadium was probably reduced directly, without adsorption, and molybdenum, arsenic, and selenium were precipitated by bacterially generated sulfide species. The Morrison sediments were originally deposited chiefly as redbeds and bleached during the mobilization and dispersal of their contained organic matter. (Diss. Abstr. Int., B)

Oceanography

Refer also to abstracts 15471, 15539, 15782, and 15808.

15799 (AEC-tr-7214, pp 187-219) ^{90}Sr AND ^{137}Cs IN THE WATERS OF THE ATLANTIC OCEAN AND ITS SEAS IN APRIL TO JULY 1964. Gedeonov, L. I.; Dmitriev, V. N.; Ivanova, L. M.; (and others). Translation of A-AC-82/G/L-1168.

From USSR reports on radioactivity in man and the environment.

The results of investigations of the content of ^{90}Sr and ^{137}Cs in the waters of the Atlantic Ocean and its seas, conducted on the research vessel Mikhail Lomonosov in 1964 are presented. The method of concentration from a single sample of sea water was used to determine ^{90}Sr and ^{137}Cs. The results are given for analyses of 70 samples of sea and ocean water, 28 of which were abyssal. The variations of the mean concentration of ^{90}Sr in the surface waters in the northern and tropical zones of the Atlantic from 1961 to 1964 were traced. Data were obtained for the first time on the mean concentration of ^{137}Cs in three zones of the Atlantic. The variations of the mean concentration of ^{90}Sr follow the variations of the average annual rate of fallout from the atmosphere. Waters from different horizons down to a depth of 2000 meters were tested for ^{90}Sr and ^{137}Cs content. It was found that in 1964 the concentrations of ^{90}Sr and ^{137}Cs were higher on each horizon than in 1963, that is, the investigated radionuclides had penetrated to a greater depth than the year before. In 1964 the amount of ^{90}Sr in the upper 1000 meters of water was 55 mCi/km^2, and of ^{137}Cs, 100 mCi/km^2. The ratio of the ^{137}Cs and ^{90}Sr concentrations, determined for waters of the Atlantic Ocean was 1.7. (auth)

15800 (AEC-tr-7214, pp 227-48) ^{90}Sr AND ^{137}Cs IN THE WATERS OF THE ATLANTIC OCEAN AND ITS SEAS IN AUGUST TO NOVEMBER 1963. Ankudinov, E. P.; Gedeonov, L. I.; Ivanova, L. M.; (and others). Translation of A-AC-82/G/L-1167.

From USSR reports on radioactivity in man and the environment.

The results of investigations of ^{90}Sr and ^{137}Cs in the waters of the Atlantic Ocean and its seas, conducted on the research vessel Mikhail Lomonosov in 1963 are presented. The method of concentration from a single water sample of cesium in the form of mixed ferrocyanide and strontium in the form of carbonate was used for the first time to determine ^{90}Sr and ^{137}Cs. The results are given for analyses of 100 samples of sea and ocean water, 29 of which were abyssal. It was ascertained that in the 1962 to 1963 period the level of concentration of ^{90}Sr rose in the surface waters. This confirms that the ^{90}Sr and ^{137}Cs concentrations in the surface layer of the ocean depend on the time of their arrival. On the basis of abyssal profiles completed it was calculated that the amount of ^{90}Sr and ^{137}Cs in the upper 200-meter level of the ocean alone exceeds that on dry land. The fact of an elevated concentration of ^{90}Sr and ^{137}Cs in the waters of the ocean in the equatorial zone was established. It was determined that in the waters of the Mediterranean basin, especially in the Black Sea, a high level of ^{90}Sr and ^{137}Cs is present. (auth)

Seismology

Refer also to abstract 15807.

15801 (NVO-1163-TM-18) METHODS TO PREDICT GROUND MOTIONS FROM FUTURE UNDERGROUND NUCLEAR DETONATIONS IN THE PICEANCE CREEK BASIN, COLORADO. Whipple, A. P.; Williams, S. L. (Environmental Research Corp., Alexandria, Va.). 13 Jan 1970. Contract AT(29-2)-1163. 112p. (PNE-R-40). Dep. NTIS.

Methods for predicting the amplitude and frequency composition of the ground motions expected from proposed detonations in the Piceance Creek basin are described. The salient elements of the experience gained from Gasbuggy and Rulison, two detonations in sedimentary basins, are emphasized. In particular, the basic aspects of scaling theory, which account for the effect of yield and device burial depth on the generated seismic motions, are highlighted, stressing the manner in which this theory is applied. Predictions of the peak vector particle ground motions, and the peak horizontal ground motions, are made for three arbitrary detonations having yields of 40, 80, 160 kt, and device depths of burial of 4000, 6000, 8000, 10,000, and 12,000 feet. Pseudo-relative velocity (PSRV) spectra are predicted for the same device yields and for device depths of burial of 4000, 8000, and 12,000 feet. These predictions, although somewhat generalized, illustrate the scaling technique and provide a useful basis for preliminary planning for future detonations in the Piceance Creek basin. These predictions can be applied for 12 specific sites in the Piceance Creek basin which recorded Rulison as well as for arbitrary sites distributed over the distance range 10 to 60 km, provided the proposed detonation occurs in the same medium and has about the same location as the Rulison detonation. For different locations in the Piceance Creek basin, estimates of the ground motion predictions can be obtained by using the enclosed Rulison data and applying scaling factors, displayed in graphical form, which account for changes in source to recording site distance, yield and depth of burial. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 15754, 15786, 15801, 15814, 15863, and 16079.

15802 (NVO–79) PHYSICAL AND BIOLOGICAL EFFECTS: MILROW EVENT. Merritt, Melvin L. (Nevada Operations Office (AEC), Las Vegas). Dec 1970. 113p. Dep. NTIS.

Separate abstracts were prepared for the seven sections of this report. (C.H.)

For abstracts of individual sections see: 15803–15808, and 16079.

15803 (NVO–79, pp 1–8) INTRODUCTION AND HISTORY. (Nevada Operations Office (AEC), Las Vegas).

From Physical and biological effects: Milrow Event.

Milrow was a nuclear detonation of about 1 Mt fired 4000 ft deep at Amchitka Island, Alaska, on Oct. 2, 1969. It was a "calibration" event designed to give base-line information from which the effects of a larger shot at this site could be predicted so that the safety of such a proposal could be judged. The history of Amchitka Island and the background information used in selecting this site for the calibration shot are presented. (L.C.L.)

15804 (NVO–79, pp 9–19) GROUND AND WATER SHOCK. (Nevada Operations Office (AEC), Las Vegas).

From Physical and biological effects: Milrow Event.

Methods used for predicting and measuring the surface ground motion and underwater (sea bottom) shock from the Milrow Event on Amchitka Island, Alaska are described. From the results obtained it was concluded that: ground shock at Amchitka follows the same general pattern as ground shock elsewhere, scales by the same rules, and has scaling breakdown at distances greater than a few miles in roughly the same way; and underwater measured overpressures are as much affected by the depth of water and depth of measurement as by distance from the shot. The vertical motion of the sea floor is nearly what it would be if the sea were drained off, but the resulting pressures can be very much reduced by rarefractions reflected from the upper surface of the water. Pressure is zero at the surface of the water, although the motion there doubles and increases linearly with depth. (L.C.L.)

15805 (NVO–79, pp 20–40) SURFACE PHENOMENA. (Nevada Operations Office (AEC), Las Vegas).

From Physical and biological effects: Milrow Event.

The immediate and postshot surface effects of the Milrow Event at surface zero and beyond are described in detail, and include the effects on geologic structures, lake surfaces, and buildings. Measured data on the vertical displacement of surfaces at distances to 10,000 ft from surface zero are compared with predicted displacements. (L.C.L.)

15806 (NVO–79, pp 41–8) RADIOACTIVITY. (Nevada Operations Office (AEC), Las Vegas).

From Physical and biological effects: Milrow Event.

Methods used to measure the release of radioactivity from both Long Shot and Milrow Events on Amchitka Island, Alaska are discussed. The surface atmosphere at both sites continues to be monitored for gamma activity. Surface waters near both sites are monitored for tritium content. Ground waters of the Milrow site area are monitored for tritium content. The mechanisms of tritium transport in Milrow site ground waters are described. After more than a year, no release of radioactivity from Milrow has been detected. The activity formed remains near the explosion point at 4,000 ft depth. Predictions are made that, when the chimney fills with ground water and normal ground water flow patterns are resumed, the flow will be so slow that H_3 concentrations will be reduced below the Radiation Concentration Guide for drinking water for the general public before the tritiated water reaches the ocean. (L.C.L.)

15807 (NVO–79, pp 72–96) SEISMIC EFFECTS. (Nevada Operations Office (AEC), Las Vegas).

From Physical and biological effects: Milrow Event.

The seismic effects of the Milrow Event are described in detail. The geology and seismic history (including tabulated data on earthquakes since 1901) are discussed. Preshot predictions on these seismic effects are presented. The instrumentation for the Milrow seismic program is described, and the results, in terms of seismicity patterns for the Amchitka Island region before and after Milrow are presented. The results of both permanent and transient strain measurements are compared with data on other events. It was concluded that the seismic experiment was imperfect due to the limited land area site, the short time for preshot measurements, and the fact that 6 of 10 ocean-bottom seismometers did not function. However, the results showed that the Milrow Event had a body wave magnitude of 6.5 and surface wave magnitude of 5.0, and produced no change in regional seismic activity. The aftershock activity was confined to a local, shallow region, and ceased abruptly at collapse. The transient strains agreed well in amplitude with similar strains from Benham. The permanent strain steps seemed to be associated with slips or faults not visible at the surface, i.e., surface cracking and faulting were much less noticeable and smaller in size than on similar shots at NTS. Additional information on the geological structures and tectonic setting of Amchitka Island were obtained. (L.C.L.)

15808 (NVO–79, pp 97–106) TSUNAMI EFFECTS. (Nevada Operations Office (AEC), Las Vegas).

From Physical and biological effects: Milrow Event.

The tsunami effects of the Milrow Event are described. Data on earthquake-generated tsunamis in Alaska and Kamchatka from 1737 to 1965 are tabulated. Preshot predictions on the probability of triggering an earthquake are discussed. The instrumentation activities and equipment for these studies are described. The results showed that Milrow did not cause measurable waves. As predicted, only an earthquake triggered by the explosion would have caused a tsunami, and, since there was no earthquake, there was no tsunami. (L.C.L.)

15809 PARTICULAR FEATURES OF RADIOISOTOPE WEAR MEASUREMENT, EXPECTED RESULTS, AND SOME ECONOMIC CONSIDERATIONS. Polzer, G. (Technische Hochschule Karl-Marx-Stadt, Ger.). Isotopenpraxis; 6: 272–6 (Aug 1970). (In German).

Reference is made to the complexity of processes as well as to the reasons and consequences of mechanical stress applied to solids. Problems are indicated that may arise through investigation of wear processes. Especially mentioned are particular problems of radioisotope wear measurement. Description is given of the performance and evaluation of wear measurements on small slide bearings for hermetic refrigerating machines with discontinuous determination of wear, making use of scintillation counters without filtering devices. In the nuclear reactor of ZfK Rossendorf the specimen parts were activated by neutron irradiation. This method proved to have a detection limit of 5×10^{-7} g and a minimum relative random sensitivity of ±18% in the optimum range with variation of one factor. Finally some actual results of radioisotopic wear measurement are supplied. Allusion is made to the economic profit of such investigations. (auth)

15810 PEACEFUL NUCLEAR EXPLOSIONS. Johnson, G. W. (Gulf General Atomic, San Diego, Calif.). pp 103–24 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

A review of the Plowshare Project activities is presented. Results from experimental shots are described. Applications for nuclear explosions are discussed for shallow burial, intermediate-depth burial, and deep burial conditions. 35 references. (D.C.C.)

Facilities and Equipment

Refer also to abstracts 15871, 15874, 15876, 15964, 16141, 16393, 16563, and 16568.

15811 FAST VALVE CONTROL CAN IMPROVE TURBINE-GENERATOR RESPONSE TO TRANSIENT DISTURBANCES. Aanstad, O. J.; Lokay, H. E. (Westinghouse Electric Corp., New York). Atompraxis; 16: 403–6(Nov-Dec 1970).

The modern electrohydraulic turbine control system has the ability to rapidly close the turbine interceptor valves upon detection of a severe fault system. Computer studies have indicated that fast turbine valve control can improve unit stability, thereby increasing the critical fault clearing time. (auth)

15812 RELEASE LATCH ACTUATED BY TEMPERATURE EXCURSION. Grijalva, Ramon J.; Queener, George F. (to United States Atomic Energy Commission). U. S. Patent 3,546,996. 15 Dec 1970. Filed 10 Apr 1969.

A latch mechanism is described in which colinear elements constructed of materials having dissimilar temperature coefficients of

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elongation are arranged to allow differential elongation which affects arming of the latch device during a temperature excursion exceeding a predetermined limit. The elements then contract differentially to apply a strain sufficient to rupture a retainer element on reversal of the temperature excursion. The latch device may be utilized as a severable link or retainer in a fail-safe mechanism to prevent further operation of a device subjected to an excessive temperature excursion. (Offic. Gaz.)

15813 ENGINEER LOOKS AT THE ENERGY DILEMMA. Graham, Robert W. (Lewis Research Center, Cleveland). Mech. Eng.; 93: No. 2, 40-6(Feb 1971).

Aspects of the increased and growing demands for energy are examined. It is noted that problems of pollution and fossil fuel supply depletion point to an urgent need for revision of engineering priorities before decisions affecting the future are made. Challenges associated with development of nuclear power, more pollution-free energy sources, and new concepts of transportation are analyzed. (J.R.D.)

15814 FOULNESS BLAST TUNNEL. Read, J.; Whiteside, T. (Atomic Weapons Research Establishment, Foulness, Eng.). Atom (London); No. 171, 10-13(Jan 1971).

This explosively driven shock tube was designed to produce air blast waves similar in shape and duration to those from small nuclear or large chemical explosions. A small charge of explosive can simulate a much larger charge and it is shown that the pressure-time history of the blast wave in the tunnel is almost identical with that from a large charge. Economically, a blast for which the explosive cost £7 in the tunnel can be compared to one which the explosive in the field would have cost £100,000 and the high cost of staging field trials for large detonations is avoided. The design, construction and operation of the tunnel is discussed. Trials have been carried out on buried structures, on objects on a turf surface, on floating targets and on numerous models on a platform in a test section. (UK)

15815 CALCULATION AND CONSTRUCTION OF NUCLEAR STEAM GENERATORS. Upmalis, A. Waerme; 76: No. 12, 1-8 (1970). (In German).

Calculation methods used in designing nuclear power plant boilers are presented and data on heat transfer per unit surface are given. Examples of internationally-used steam generator designs for different types of reactors are included. (INIS)

15816 TURBINE GENERATOR FOR A NUCLEAR POWER PLANT. Nishi, Masataka; Kawamura, Takashi (Hitachi Ltd., Ibaraki, Japan). Hitachi Hyoron; 52: 106-12(Feb 1970). (In Japanese).

The turbine generators for nuclear power plants are the tetrapolar generators of 1800 or 1500 rpm. Compared with the bipolar generators of 3600 or 3000 rpm for thermal power plants, those for nuclear-use largely differ in the structure of rotors. In consequence, there are problems in the structural materials such as the large shaft and retaining ring, however they are surmountable with the technology accumulated in the construction of the generators for thermal-plant use. Due to the ease of rotor cooling, however, the ultra large capacity generators have emerged prior to the generators for thermal power plants. In comparison with the bipolar generators for thermal plant use, the tetrapolar generators for nuclear power plants are described as to construction details, electrical characteristics, and operational features. Turbine generators for nuclear use in general are reviewed and the advances expected in the future summarized. (Japan)

15817 PLUTONIUM SALT TRANSPORT FACILITY (24 May 1969) (Engineering Materials). (Argonne National Lab., Ill.). (CAPE-2052).

46 drawings.

A glovebox facility, which contains process equipment for the pyrochemical process for the recovery of Pu and U from fast reactor fuels, is described. Included are the glovebox vessels, and associated equipment for decladding, reduction, and U recovery. Greater than one ton/day of short-cooled fuel with Pu and U recoveries greater than 99% and decontamination factors greater than 10^6 can be handled. The process includes: dissolution of the stainless steel cladding in liquid Zn which eliminates the need for disassembly, Na removal, chopping and/or shearing, complete removal and collection of the volatile fission products in the head-end vessel, high-performance cross-current extraction for efficient core earth and noble gas removal in semicontinuous mixer-settlers, Pu product isolation in a slab-geometry solvent-metal distillation unit, and resynthesis of the fuel to mixed U and Pu oxides in a fluid-bed converter. (For details see TID-4100 Suppl. 62) (see also NSA 24: 257) (F.S.)

15818 LARGE-SCALE MIXER-SETTLER FACILITY (5 Sep 1968) (Engineering Materials). (Argonne National Lab., Ill.). (CAPE-2053).

37 drawings.

This facility was designed to demonstrate the transport of U through a salt phase and to determine the amount of entrainment of the liquid-metal phase in the salt. Components of mixer-settlers are tested and design concepts are evaluated under typical operating conditions in an inert atmosphere. The facility consists of a centrifugal pump, pump-sump tank, constant-head tank, weigh tank, and connecting lines. The equipment is fabricated from resistance-heated Type 304 stainless steel. During operation, ~3 gal/min of liquid salt ($MgCl_2$-30 mole % NaCl-20 mole % KCl) is pumped by the centrifugal pump from the sump tank into a constant-head tank. Most of the salt flows from this tank directly back into the sump tank. However, a fraction of the salt is diverted and flows by gravity through two mixer-settlers, through the weigh tank, and back into the constant-head tank. This stream is controlled by the liquid head and a valve in the constant-head tank. The salt flow rate is measured by weighing the salt collected in the weigh tank. (For details see TID-4100 Suppl. 62) (see also NSA 24: 257) (F.S.)

15819 FLUID-BED DENITRATOR (1 Jun 1970) (Engineering Materials). (Argonne National Lab., Ill.). (CAPE-2057).

11 drawings.

Drawings used in constructing a fluid-bed pilot plant, which is used in the denitration of UNH and mixed nitrates of U, are presented. The spray nozzle design and location, size of the fluid bed reactor, and some details of associated equipment and instrumentation are also described. The pilot plant is located in a glove box. The glove box is 13.25 ft long, 10 ft high and 3.5 feet wide. (For details see TID-4100, Suppl. 62) (F.S.)

15820 FUJI ELECTROMAGNETIC PUMPS FOR LIQUID SODIUM. Akiyama, Shigeru; Onodera, Keiichi; Shindo, Yoshihiko (Fuji Electric Co. Ltd., Tokyo). Fuji Jiho; 43: 189-93(Feb 1970). (In Japanese).

The Fuji electromagnetic pumps used for the transfer of liquid sodium were developed for use in experimental fast breeder reactors. These are based on the principle of the Faraday alternating-current electromagnetic pump. The alternating magnetic field passing through a pump reverses synchronously with the current passing through the fluid. A large low-voltage current is supplied with a step-down transformer, and the low-voltage secondary winding is connected to the narrow opposite sides of the flattened pump duct. The faulty contact of electrodes with the fluid path is a design problem common to almost all types of electromagnetic pump. A rectangular duct must be as thin as possible, and have low electrical conductivity. The one-body construction of duct and electrodes eliminates this fault. The fluid path is made of stainless steel, and high electrical conductivity is maintained with special construction. The pumps have the great advantage of having no moving parts and no shaft seal. They have shown reliable performance in the Na experimental loop of Japan Atomic Energy Research Institute. (Japan)

15821 GAS TURBINES FOR LARGE ATOMIC POWER PLANTS. Rydland, K. (Norges Tekniske Hoegskole, Trondheim, Norway). Maskin; 4: 12-14(28 Jan 1971). (In Norwegian).

Closed cycle gas turbines have been in use for 20 to 25 years based on the Ackeret-Keller system using a Brayton cycle. A more widespread adoption of the system is dependent on improved structural materials, but it should be well suited for use with a high temperature helium cooled reactor, using a direct cycle. Typical data for a projected 300 MW station are presented and a brief description of the turbine, compressors and heat exchangers is given. Such a station could be built as an integrated unit, with reactor, turbine and compressor, and heat exchangers contained within a prestressed concrete pressure vessel. Alternative stations of 100 MW and 600 MW are also projected but the 300 MW plant will be the first built, and is expected to be in operation about the New Year 1974. (Norway)

15822 SOME PROBLEMS ON MANUFACTURING FOR LARGE NUCLEAR STEAM TURBINES. Kumeno, Kozo; Kitagawa, Yuji (Hitachi Ltd., Ibaraki, Japan). Hitachi Hyoron; 52: 113-18 (Feb 1970). (In Japanese).

Research and development work on construction of steam turbines for nuclear power plants is described. In 1968, a 138,600 kW nuclear turbine for West Pakistan was completed, which is being installed at present on the site. In the meantime, other major components for various large-capacity nuclear turbines (1,800 rpm, and TC4F-38, TC6F-38, and TC4F-43 types) were being constructed. Thus, the technology was established for manufacturing large-capacity nuclear turbines, including the design of

1,000,000 kW turbines. The characteristics of nuclear turbines (the tendency toward large size turbines, employment of steam-moisture separators, and corrosion by wet steam) and problems in construction of large-capacity nuclear turbines e.g., turbine room, rotor, moving blades, diaphragm, steam-moisture separators and control are discussed. (Japan)

15823 OARAI ENGINEERING CENTER OF POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION. Kuramoto, Masaaki (Power Reactor and Nuclear Fuel Development Corp., Tokyo). FAPIG (Tokyo); No. 56, 224-30(Mar 1970). (In Japanese).

In Oarai, Ibaraki-Ken, large-scale research and development facilities are being installed for power reactors such as an advanced thermal reactor (D_2O moderated and light-water cooled) and a sodium-cooled fast breeder reactor. Of these, a D_2O critical assembly (DCA), component test loop (CTL), and a Na loop have been completed and are in use. The site, which was a construction office until recently, was formally designated as the Oarai Engineering Center in March 1970. With an experimental fast reactor whose construction will be started shortly at the site and completion of other facilities it will become a worldwide engineering center for the development of power reactors. (Japan)

15824 QUICK-CLOSING VALVE FOR EMPLOYMENT IN WATER–STEAM. Agostini, V.; Premoli, A. (CISE, Milan). Energ. Nucl. (Milan); 18: 45-54(Jan 1971). (In Italian).

A quick-closing valve model is presented which has been designed and manufactured at CISE in connection with the development of a measurement technique for coolant hold-up, in steady-state and transient conditions, in power channels cooled by evaporating water. This valve is characterized by the absence of any leakage and by a closing time shorter than 10 μsec; it has been tested up to 70 kg/cm^2 pressure in steam-water. Moreover, the valve was developed according to a three-way scheme, which can also be used as a quick-opening valve. (auth)

15825 DEVELOPMENT OF A MECHANICAL SODIUM PUMP FOR LIQUID METAL COOLED FAST BREEDER REACTORS. Ueda, Toshihiko; Iida, Seiichi; Kida, Nobuo (Mitsubishi Heavy Industries, Ltd., Kobe, Japan. Kobe Tech. Inst., Japan). Mitsubishi Juko Giho; 7: 760-6(Nov 1970). (In Japanese).

The development of fast breeder reactors is being undertaken by Power Reactor and Nuclear Fuel Development Corporation. Liquid sodium is used as the reactor coolant. In order to verify the design of the main liquid sodium circulation pumps of the FBR, a sodium pump was produced and tested in a sodium test loop. The main parameters of the pump are as follows: type, free surface centrifugal pump; delivery flow rate of 0.9 m^3/min; total delivery head of 55 m Na; rotating speed of 2950 rpm; and sodium temperature of 400°C. The maximum temperature of liquid sodium used was 500°C. No trouble was experienced. The results of the test were satisfactory. The design and the test run of the pump are summarized. (auth) (Japan)

Heat Transfer and Fluid Flow

Refer also to abstracts 15815, 15824, 16501, 18153, 18244, and 18252.

15826 (RLO–2227-T-4-1) NATURAL CONVECTION HEAT TRANSFER IN LIQUID METALS. Progress Report, April 1, 1969–December 31, 1970. Welty, James R. (Oregon State Univ., Corvallis. Dept. of Mechanical and Nuclear Engineering). Contract AT(45-1)-2094. 139p. Dep. NTIS.

Activities in an investigation conducted to gain better understanding of natural convection heat transfer are reported. The test geometry used was a flat plate immersed in a pool of mercury. It was found that the velocity and temperature profiles have an x dependency as well as a modified Grashof and Grashof number dependency. This was predicted by perturbation but not by similarity or integral analysis. Available analytical methods do a poor job of predicting velocity profiles and only a fair job of predicting temperature profiles. The curve trends reported are valid. However, sources of error exist which have a potential to alter these results significantly. Results of analyses of heat transfer equations and temperature profiles suggest that the heat transfer may be higher than previously expected. The pseudo-constant temperature plate is, at the very best, a first approximation and the results obtained must be used with care (particularly, the heat transfer equation). Thermo-barrier film models are helpful, but incomplete. Additional experiments are desirable, particularly with other liquid metals, so that the variation of heat transfer with Prandtl number can be investigated. The results raise questions about the adequacy of presently-used analytical boundary conditions for the liquid metal range. Similarity solution boundary conditions, in particular, are questioned. (auth)

15827 (TID–25395) DISCHARGE MEASUREMENTS USING RADIOISOTOPES AT FLATIRON AND POLE HILL POWERPLANTS. Schuster, Jack C.; Hansen, Robert L. (Bureau of Reclamation, Denver, Colo. Office of Chief Engineer). Aug 1970. 35p. Dep. NTIS.

Radioisotope techniques and equipment were developed to improve methods for measuring flow rate in high-head turbines and pumps. Phase V, the last of a series of field measurements, was performed at Flatiron and Pole Hill Powerplants in Coloradc Studies of 4-point injection and sampling over a mixing length of 36.5 pipe diameters of 7-ft pipe (2.13 m) showed that radiation sampling and counting techniques were satisfactory. The mixing length appeared to be short for satisfactory mixing and accurate discharge measurement. A demonstration of the techniques at Pole Hill Powerplant produced satisfactory measurements for a mixing length of 255 diameters of 8-ft pipe. Discharge of 400 cfs computed by the dilution, integrated sample, and total count methods varied up to about 2%, indicating that further refinement of sampling and counting techniques will not reduce significantly the inaccuracy below the estimated probable 2 Sigma error of 1.5%. (auth)

15828 SPECIFIC HEAT OF THE LIQUID MIXTURES OF NEON AND HYDROGEN ISOTOPES IN THE PHASE-SEPARATION REGION. I. THE SYSTEM Ne–H_2. Brouwer, J. P.; Van den Meijdenberg, C. J. N.; Beenakker, J. J. M. (Rijksuniversiteit, Leiden). Physica; 50: 93-124(23 Nov 1970).

The phase separation in the liquid binary system of neon and normal hydrogen has been investigated by measuring the specific heat at saturation for different compositions between 24 and 30°K. The phase-separation curve has been determined. The coordinates of the upper critical consolute point are T_c = 28.93 K and x_{H_2} = 0.308. The temperature at which the liquid phase-separation curve meets the freezing curve is T_M = 24.27°K. The excess enthalpy, the excess entropy, and the excess Gibbs function of the liquid mixture have been calculated as functions of temperature and composition. The vapor correction for heat-capacity measurements of a two-component liquid-vapor system is discussed. (auth)

15829 SPECIFIC HEAT OF THE LIQUID MIXTURES OF NEON AND HYDROGEN ISOTOPES IN THE PHASE-SEPARATION REGION. II. THE SYSTEM Ne–D_2. Brouwer, J. P.; Vossepoel, A. M.; Van den Meijdenberg, C. J. N.; Beenakker, J. J. M. (Rijksuniversiteit, Leiden). Physica; 50: 125-48(23 Nov 1970).

The phase separation in the liquid binary system of neon and normal deuterium has been investigated by measuring the specific heat at saturation for different compositions between 24 and 27.5°K. The phase-separation curve has been determined. The coordinates of the upper critical consolute point are T_c = 25.71 K and x_{D_2} = 0.354. The temperature at which the two-liquid region is terminated by the solidification of the neon is T_M = 23.86°K. The excess enthalpy, the excess entropy, and the excess Gibbs function of the liquid mixture have been calculated as a function of temperature and composition. For the systems Ne–nH_2 and Ne–nD_2 the critical coefficient β has been determined from the shape of the phase-separation curve. A comparison of the experimental results with the results of Prigogine's theory for isotopic mixtures of quantum fluids has been made. Only qualitative agreement has been found. (auth)

15830 A METHOD OF STORING HEAT ENERGY PRODUCED BY RADIOACTIVE RADIATION OR BY NEUTRON ENERGY. (to Kernforschungsalage Julich Gesellschaft mit Beschrankter Haftung). British Patent 1,218,928. 13 Jan 1971. Priority date 17 Feb 1967, Germany.

A method is described for storing energy produced by radioactive decay or neutron action. The energy is applied to a gaseous compound to decompose it into its components. The components are transferred to the desired area separately or as a low-temperature mixture and allowed to recombine producing heat. (J.R.D.)

15831 MOVEMENTS OF GENERATING VAPOUR BUBBLE IN SATURATED POOL BOILING. 2. MOVEMENTS IN BURNOUT POINT AND TRANSIENT BOILING. Iida, Yoshihiro (Yokohama National Univ., Japan); Kobayashi, Kiyoshi. Nippon Kikai Gakkai Ronbunshu; 36: 446-53(Mar 1970). (In Japanese).

The movements of vapor bubbles at heat surfaces near burnout points during transient boiling were investigated. The production of dry region on the heat surface occurs before burnout heat flux is effective and by that time the mean surface fraction of dry region is increased by super heat in transient boiling regions. It appears that transient boiling is followed by nucleate boiling limit-

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ing the drying process on heat transfer surfaces, and that the mechanism of decreasing heat flux is due to the decrease of effective heat surface during superheating at the surface. (Japan)

15832 EFFECTS OF THE RATE AND VAPOR CONTENT OF THE COOLANT VAPOR-LIQUID MIXTURE ON THE HEAT TRANSFER COEFFICIENT DURING WATER BOILING IN TUBES. Bogdanov, F. F. At. Energ. (USSR); 29: 454-6(Dec 1970). (In Russian).

A new generalization for experimental data was obtained considering the coefficient of coolant heat transfer as a function of the total vapor content and the vapor–liquid motion during cooling in the channel. The generalization is based on the equation previously obtained by V. K. Daruga et. al., (Preprint of FEU, 1970) and expanded by the thermodynamic semilitude criteria and applied in experiments with the heat transfer during boiling of water on practically clean heated surface of narrow annular channels obtained at significantly high thermal fluxes [q = (1 to 3) 10^6 kcal/m^2hr] and at pressures of p = 175 atm. Experimental data are given in graphic form for heat transfer from boiling water in oxidized tubes at 50, 120, and 140 atm. (R.V.J.)

15833 MASS TRANSFER OF DECAYING PRODUCTS WITH AXIAL DIFFUSION IN CYLINDRICAL TUBES. Tan, C. W. (Cooper Union for the Advancement of Science and Art, New York); Hsu, Chia-jung. Int. J. Heat Mass Transfer; 13: 1887-1905 (Dec 1970).

The problem of steady-state mass transfer with axial diffusion of decaying products resulting from the disintegration of an inert gas is considered for a slug and a Poiseuille pipe flow. The products of disintegration are filtered out at the tube inlet, but are again generated by radioactive decay of a flowing inert gas along the cylindrical tube. The radio-elements diffuse axially and radially to the tube walls where they decay into other radio-elements. Because of the Péclét number dependence, the effects of the axial diffusion on the concentration distribution, the local Sherwood number, and the F(ξ) values are studied for Péclét numbers of 1, 5, 10, 20, 30, 50, 100 and ∞. For the Poiseuille pipe flow, asymptotic expressions for the eigenvalues and the eigenfunctions are also obtained. (auth) (UK)

15834 THERMAL STRESSES IN HEAT-GENERATING MULTI-BORE SQUARE OR CIRCULAR REGION. Takeuti, Yoitiro (Shizuoka Univ., Japan). Nucl. Eng. Design; 14: 201-10(Nov 1970).

A general solving method is given for problems of the steady state two-dimensional thermal stress distributions in heat-generating square or circular cylinder which contains many circular holes symmetrically placed around the centers with uniform heat generation having thermally insulated outer boundaries. The graphical illustrations of the thermal stress distributions are given for the problems of heat-generating square cylinders with four circular holes, and of heat-generating circular cylinders, with three or four circular holes. (auth)

Isotope Technology

Refer also to abstracts 15523, 15827, 15857, 15858, 15870, 15889, 15917, 15931, 15957, 16212, 16260, 16285, 16393, and 16400.

15835 (ANL–7760(Pt.1), pp 33-5) ^{244}Cm AND ^{145}Sm–^{145}Pm X-RAY SOURCES. Kastner, Jacob; Friedman, A. M.; Oltman, B. G.; Eckerman, K. F. (Argonne National Lab., Ill.).

From Radiological Physics Division annual report.

Characteristics and limitations are presented for ^{244}Cm and ^{145}Sm–^{145}Pm being developed as potential x-ray sources for the bone scanning technique originally established by Professor John Cameron and his group at the University of Wisconsin. (auth)

15836 (INSD–2873-44) SNAP 19 TAGS 85/2N, RTG POWER SYSTEMS. Third Semi-Annual Progress Report, July 1, 1970–December 31, 1970. (Teledyne Isotopes, Timonium, Md. Nuclear Systems Div.). Jan 1971. Contract AT(29-2)-2873. 144p. Dep. NTIS.

Work on re-design of the heat source capsule support to minimize impact loading on the generator heat shield and converter components during severe dynamic environments of the Pioneer launch is described. A firm, lasting constraint of the fuel capsule was conceived, implemented, and tested successfully. This enabled fabrication and fueling of the first RTG, S/N 37, with confidence in its ability to withstand qualification level testing. Other generator design and analysis work is reported on design of integrally machined handling lugs to facilitate fabrication, modification of intermodule electrical connection to provide strain relief, replacement of safety wiring with bolt retainers to expedite fueling operations, RTG design for Viking mission, mass properties prediction updated to include measured component weight and dimensions, component structural analyses performed to validate adequacy of the heat source support, updated reliability and performance evaluation for the Pioneer mission, and prediction of RTG design performance for the Viking application. Work on heat source development is reported on thermal stress analysis of heat shield during reentry, evaluation of graphite and zirconium oxide materials properties, thermal analysis of hard-mounted fuel capsule design, investigation of alternate heat source components such as the HRD and thermal switch, preparation of test procedures in support of safety evaluation tests, and preliminary evaluation of impact tests of heat sources. Work on generator and component testing is reported on long-term tests of ETG's S/N 26 and S/N 29, performance of load voltage parametric and hot leak tests for ETG's and RTG S/N 37, cold vibration testing in development of fuel capsule support, completion of qualification level vibration testing on ETG S/N 36, completion of electrical heater endurance tests, evaluation of pressure containment capability of the RTG housing, investigation of viton, solder, and metal-v seals at the electrical connector, and thermal coating studies for the Viking mission. Safety evaluation work is reported on analysis of misorientation during third stage burn and micrometeoroid puncture, study of environment exposing heat source and the altitude of heat source release, continuation of aerophysics effort to define the reentry flight path and heating distributions, development of thermal response analyses during reentry, and preparation of Safety Analysis Report (SAR) plan and schedule. Work on auxiliary ground equipment is reported on refurbishment of fuel capsule shipping containers, design and fabrication RTG shipping containers, modification of RTG handling adapter, design and fabrication of fueling tools, and review of Viking requirements. (auth)

15837 (MLM–1578) METALLOGRAPHIC ANALYSIS OF DART I HEAT SOURCE CAPSULE. Selle, J. E.; Fitzharris, R. E.; Kelly, M. D. (Mound Lab., Miamisburg, Ohio). 31 Dec 1968. Contract AT(33-1)-Gen-53. 48p. Dep. NTIS.

A complete metallographic analysis of the DART I heat source capsule was performed. The purpose of the analysis was to determine the extent of any reaction between the various components of the capsule. Reactions were found at all the interfaces examined although counter diffusion across these interfaces was limited to less than 80 μm. The reaction at the fuel-liner interface was complicated somewhat by reaction between the liner and impurities in the fuel. Absorption of oxygen, resulting from decomposition of the fuel, resulted in considerable increase in the hardness of the tantalum-10 wt % tungsten liner. (auth)

15838 (ORNL–4359) COMPATIBILITY DATA SHEETS FOR ^{144}Ce, ^{137}Cs, Cm, AND ^{90}Sr. Rimshaw, S. J.; Ketchen, E. E. (Oak Ridge National Lab., Tenn.). Jan 1969. Contract W-7405-eng-26. 7p. Dep. NTIS.

Data on the compatibility of Ce compounds with heat-resisting container materials are presented along with similar data for Cs, Cm, and Sr. (J.R.D.)

15839 (ORNL–TM–2960) REFERENCE DESIGN FOR AN ISOTOPE POWER UNIT EMPLOYING AN ORGANIC RANKINE CYCLE. Samuels, G.; Holcomb, R. S. (Oak Ridge National Lab., Tenn.). Jan 1971. Contract W-7405-eng-26. 78p. Dep. NTIS.

A reference design for a 5 kW(e) Rankine cycle power unit using Dowtherm A has been evolved to serve as the basis for evaluation tests in Phase II of the Isotope Kilowatt Program. The heat source consists of seven $SrTiO_3$ fuel elements 3.40 in. in diameter and 38.4-in. in length encapsulated in Hastelloy C-276. The unit is designed for undersea operation at a depth of 6000 ft and 5 yr life. The required beginning-of-life thermal output is 34 kW. The fuel elements are located on a triangular pitch in the center of a low-carbon steel heat block-shield which serves as both the shield and as a heat conductor to transfer the heat from the fuel to reentry boiler tubes located in the outer part of the shield. Saturated vapor at 600°F from the 12 reentry boiler tubes passes through a combined separator boiler drum, to the turbine and then through the regenerator to the upper head of the pressure vessel which serves as the condenser. The liquid from the condenser flows to the feed pump, passes around and cools the generator, then through the regenerator and back to the boiler drum. (auth)

15840 (ORNL–TM–3213) COMPARISON OF NICKEL AND IRON HEAT BLOCK-SHIELDS. Samuels, G. (Oak Ridge National Lab., Tenn.). Jan 1971. Contract W-7405-eng-26. 38p. Dep. NTIS.

The performance of nickel and iron heat block-shields for the Isotope Kilowatt Program is evaluated for both organic and

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steam Rankine cycle systems and for thermoelectric systems with hot junction temperatures of 1050 and 1350°F. The physical properties of nickel are much superior to those of iron or steel for use as the heat block-shield material. It has a much higher thermal conductivity, better shielding properties (higher density), does not undergo the crystalline transformation characteristic of iron or steel, and can be used in a smaller and lighter system. Its primary disadvantage is that the heat block-shield unit will cost about $35,000 more than iron or steel. However, this increase in cost will be partially offset by a reduction in the size and cost of the pressure vessel. Nickel is satisfactory for all of the systems under consideration while iron or steel is probably acceptable for all except the high temperature thermoelectric unit. In this case iron cannot be used because of excessive cladding temperatures during accident conditions. (auth)

15841 (ORNL-TM-3305) STUDY OF MINE DETECTION BY MEANS OF NEUTRON-INDUCED GAMMA RAYS. Mynatt, F. R.; Alsmiller, R. G. Jr.; Williams, L. R. (Oak Ridge National Lab., Tenn.). 11 Jan 1971. 13p. Dep. NTIS.

Neutron and photon transport calculations have been carried out to determine the feasibility of locating land mines by detecting the photons induced in the mine by the neutrons from a fission source at the earth's surface. Assuming the soil to be composed entirely of silicon dioxide, the omnidirectional photon flux per unit energy when the mine is present and absent is presented and compared. The photon flux per unit energy when the mine is present is found to be significantly different from the photon flux per unit energy when the mine is absent, but the absolute photon intensity is so small that a rather large fission source strength will be required to achieve an appreciable counting rate. (auth)

15842 (ORNL-tr-2427) IONIC CONDITIONING OF AIR. Invernizzi, C. G. Translated by Helen Warren (Oak Ridge National Lab., Tenn.), from Conference on Isotope Radiation Techniques in the Building Industry, Brussels, October 28-30, 1970. 15p. (CONF-701027-2). Dep. NTIS.

A review of air ionization and the effects of positive ions in air on man is presented. Information is included on the relations of ionization with pollution of air and the therapeutic properties of ionized air. A method of ionizing air using ^{241}Am sources is described in which electronically positive ions are collected and repelled by their unipolar charge resulting in a fan-shaped spread area. A selection method is used to emit negative ions into ambient air. If such devices are used in conditioned air they establish equilibrium, and if used in polluted air they promote precipitation of pollutants. (J.R.D.)

15843 (SC-DR-70-127) TASK 8 FUEL CAPSULE IMPACT TESTS (TRANSIT REFERENCE DESIGN). Keller, L. L. Jr.; Randall, D. E. (Sandia Labs., Albuquerque, N. Mex.). Nov 1970. 78p. Dep. NTIS.

Five Task 8 fuel capsule assemblies fabricated on the basis of preliminary Transit drawings (design status as of approximately October 1969) were impact tested to investigate their response to simulated earth impact following reentry from orbit. Two capsule assemblies were bare, and three were enclosed in graphite heat shields. The assemblies experienced considerable distortion, and in three instances the clad was breached. There was no detectable radioactive contamination on the capsule surfaces following the impact tests. (auth)

15844 (SGAE-PH-101/1970) PLASMATRON ION SOURCE FOR AN ELECTROMAGNETIC ISOTOPE SEPARATOR. Winter, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). [1970]. 14p. (CONF-700944-1). Dep. NTIS (U. S. Sales Only).

From 7th International Conference on Electromagnetic Isotope Separators and the Technique of their Applications, Marburg, Ger-

A Plasmatron ion source with slit geometry for the Seibersdorf electromagnetic isotope separator was developed; in its present state this ion source delivers well-focused noble gas ion beams in the mA-range at the collector. The influence of the various parameters on the properties of the Plasmatron ion sources is discussed and a comparison with the usual ion sources of the low pressure arc-type is made. It is shown that the Plasmatron ion source may be superior for some applications in medium size laboratory isotope separators. (auth)

15845 (TID-21015(Rev.2)) INTERPOLATED VALUES FOR THE SCHEDULE OF BASE CHARGES AND THE STANDARD TABLE OF ENRICHING SERVICES. (Oak Ridge Operations Office (AEC), Tenn. Production Div.). Jan 1971. 245p. Dep. NTIS.

A schedule of base charges for UF_6 effective February 22, 1971 applicable to UF_6 sold or leased by the AEC is presented. The base charges and work units for enriching services and separations apply to assay increments varying from 0.02 to 10.00 wt% ^{235}U in the UF_6. (J.R.D.)

15846 (WANL-4182-3) PHASE-II, FINAL REPORT. Period Covered: March 1, 1970-June 30, 1970. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Nov 1970. Contract AT(30-1)-4182. 22p. Dep. NTIS.

Efforts devoted to design of the final Advanced Prototype System are summarized. Results of principal tests and analyses performed in support of the design are included along with results of safety reviews. (J.R.D.)

15847 WEAR TESTS CARRIED OUT ON BRUSH-ROTOR SYSTEMS MAKING USE OF LABELLED ASSOCIATED PARTS. Wagner, K.; (Zentralinstitut fuer Physikalische Chemie, Berlin); Pfeil, B.; Brutschin, F.; Lenz, R.; Ostermay, G. Isotopenpraxis; 6: 269-71(Aug 1970). (In German).

Wear studies with ^{110m}Ag-labeled graphite- and copper-graphite-brushes on unlabeled carbon- and metal-rotors are reported, and wear experiments with radioactive labeled carbon-(^{110m}Ag) and red brass-rotors (^{64}Cu, ^{65}Zn, ^{113}Sn, ^{117m}Sn) are described. (auth)

15848 NUCLIDES OF FAR-OFF STABILITY REGIONS AND PROBLEMS OF ON-LINE ELECTROMAGNETIC SEPARATION. Zuk, Wlodzimierz (Marie Curie-Sklodowska Univ., Lublin). Postepy Fiz.; 21: 471-97(1970). (In Polish).

The possibility of production and investigation of short-lived isotopes in the far-off stability regions is discussed. Some nuclear reactions used for the production of short-lived nuclides and the actual results of their investigations are presented. The methods of on-line electromagnetic mass separation are reported in a more detailed manner and results are given of experiments obtained for light masses, some medium-weight and super-heavy elements. (auth)

15849 ^{252}Cf PROGRESS, NUMBER 6, JANUARY 1971. Californium-252 Progr.; No. 6, 1-52(Jan 1971).

ACTIVATION ANALYSIS—californium-252 source for, evaluation of
ALUMINUM—determination by activation, evaluation of beryllium-plutonium-238 and californium-252 sources for
CALIFORNIUM-252—shielding of, materials for
—fission in tissues, dosimetry of radiation from
—availability beginning Feb. 1971
—separation and purification of 110 mg of
—preparation, properties, and uses of
—uses as neutron source in activation analysis and process control
—uses as neutron source in nondestructive assay device for nuclear materials management
COAL—analysis for sulfur by prompt γ activation using californium-252 source, evaluation of
FLUORINE—determination by activation, evaluation of beryllium-plutonium-238 and californium-252 sources for
NEUTRON SOURCES—shielding of californium-252, materials for
—calibration of californium-252, methods for
RADIATION DOSIMETERS, THERMOLUMINESCENT—development of polyethylene moderated, for neutron dosimetry
RADIOGRAPHY, BIOMEDICAL—neutron source for, evaluation of californium-252
RADIOGRAPHY, INDUSTRIAL—neutron source for, evaluation of californium-252
RADIOTHERAPY—neutron source for, evaluation of californium-252
SILICON—determination by activation, evaluation of beryllium-plutonium-238 and californium-252 sources for
SULFUR—determination in coal by prompt γ activation, using californium-252 source, evaluation of
TISSUES—radiation dosimetry of californium-252 in
WELL LOGGING—neutron source for, evaluation of californium-252 (P.C.H.)

15850 ^{252}Cf PROGRESS, NUMBER 5, NOVEMBER 1970. Californium-252 Progr.; No. 5, 1-44(Nov 1970).

CALIFORNIUM-252—availability and price of
—fabrication and handling of neutron sources of
—production capability for, at Savannah River Plant
—shipping casks for neutron sources of, availability of commercial
—shielding of, materials for
—uses of neutron sources of, in activation analyses and process control
MINERAL DEPOSITS—prospecting by in situ neutron activation using californium-252 source
NEUTRON SOURCES—evaluation of californium-252
—handling, shipping, and storage of californium-252
—shielding of californium-252, materials for

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RADIOGRAPHY, INDUSTRIAL—neutron source for, evaluation of californium-252
RADIOTHERAPY—neutron source for, evaluation of californium-252
SHIPPING—containers for californium-252 sources, availability of commercial
WELL LOGGING—neutron source for, evaluation of californium-252 (P.C.H.)

15851 WATER PERMEABILITY OF COATING FILMS USING A RADIOISOTOPE TRACER TECHNIQUE. Isotop. Radiat. Technol.; 8: 181-4(1970-71).

A radioisotopic tracer technique was developed for determining the moisture permeability of protective coatings. In tests with epoxy and alkyd resins, the method was more sensitive and rapid and results were more precise than by the ASTM method for measuring film penetrability to moisture. (auth)

15852 EXPERIMENTAL SELF-LUMINOUS OVERHEAD-TYPE TRAFFIC SIGN. Dooley, Harry H. (American Atomics Corp., Tucson, Ariz.); Snyder, Jack. Isotop. Radiat. Technol.; 8: 161-63(1970-71).

The advantages, design, construction, and performance of self-luminous overhead traffic signs containing ^{85}Kr are discussed. (L.C.L.)

15853 POTENTIAL INDUSTRIAL APPLICATIONS OF THE ^{57}Fe MOESSBAUER EFFECT. Terrell, J. H. (Sanders Associates, Inc., Cambridge, Mass.). Isotop. Radiat. Technol.; 8: 166-75(1970-71).

The application of the Mössbauer-effect technique to several industrially significant problems is discussed; iron-bearing materials are emphasized. A review is given of past results and of current efforts to conduct Mössbauer-effect measurements that use the 2% naturally abundant ^{57}Fe isotope and that do not require sample preparation, i.e., backscatter rather than transmission measurements. Detection schemes in the backscatter geometry that use 6.3-keV internal-conversion x rays, 14.4-keV gamma rays, or 8-keV internal-conversion electrons are compared. Potential applications of the backscatter technique to metallurgical problems are summarized; they include studies of the typing of metals, thermomechanical history, magnetic properties, corrosion products, surface-hardening processes, and metallic coatings. Preliminary results obtained with the backscatter method on a steel coupon in axial tension are included. Other industrial applications that are accomplished best with transmission geometry are also summarized. (auth)

15854 USE OF IONIZATION IN THE AIR FOR LIGHTNING PROTECTION. Berio, G. (General Protection Establishment, Vaduz, Liechtenstein). Isotop. Radiat. Technol.; 8: 178-80(1970-71).

A lightning rod which uses eight ^{241}Am sources to promote the ionization of air is described. This rod has an effective radius of 250 m and is being used extensively in Europe to protect commercial installations from lightning. (auth)

15855 NEUTRON ACTIVATION METHOD OF MEASUREMENT OF THE LOCAL WEAR USING INSERTS: WEAR MONITORS Pelekis, L. L.; Smirnov, V. I.; Taure, I. Ya. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 5, 3-9(1970). (In Russian).

A method for measuring local wear using nonradioactive inserts was developed. A silver alloy insert was used. The determination of the insert particles in the lubricant was carried out by means of neutron activation method. The method was verified for determining local and summary wear of electrical train wheels under operating conditions. (auth)

Materials Testing

Refer also to abstracts 15809, 15849, 15851, 15853, 16439, 16443, 16505, 16622, and 18139.

15856 (WHAN-SA-42) THERMAL AND INFRARED NONDESTRUCTIVE TESTING OF COMPOSITES AND CERAMICS. Green, Donald R. (WADCO Corp., Richland, Wash.). 5 Oct 1970. Contract AT(45-1)-2170. 33p. (CONF-701034-1). Dep. NTIS.

From 30th National Fall Conference of the American Society for Nondestructive Testing, Cleveland, Ohio.

The application of high-speed thermal and infrared methods to the detection of density differences, cracks, voids, and other defects in ceramics and composites is described. A single-pass induction heating method, made possible with a full-width "paint brush" heating coil, was used in infrared tests on carbon-carbon composites. Unique characteristics of the induction heating make it possible to detect cracks that are perpendicular as well as parallel to the surface of the test specimen. All of the materials were also tested using the new low-cost thermal image transducer, and the resolution and sensitivity to defects were determined. Both the infrared method and the thermal transducer method are capable of completing a test on a large area in a few seconds (not including specimen handling time). (auth)

15857 NEW SHARP-FOCUSED SOURCES FROM ^{192}Ir FOR RADIOGRAPHY. Firstov, V. G.; Mauorov, A. N.; Sul'kin, A. G.; Cherevatenko, G. A.; Yakshin, V. V. Defektoskopiya; No. 3, 95-100(1970). (In Russian).

Sharp focused sources of ^{192}Ir for use in industrial radiography were examined. The usefulness of such sources in defining defects in welds especially during quality control checks on difficultly accessible areas affording short focal lengths is pointed out. Experimental results are evaluated on the basis of component magnitudes in unclear gamma images compared with standard and sharp-focused images. (tr-auth)

15858 DENSITY MEASUREMENT BY MEANS OF BACKSCATTERING OF GAMMA RADIATIONS. Pozdneev, D. B.; Krasnoshchekov, N. V. (Gorky State Univ., USSR). Defektoskopiya; No. 3, 118-21(1970). (In Russian).

A scintillation spectrometer using a NaI(Tl) crystal, a Type UW-2 amplifier, and a Type AI-100 analyzer was used to study the differential energy spectra of scattered gamma radiation emitted by ^{137}Cs and ^{203}Hg and reflected by plexiglas, graphite, and paraffin. Values for the scattering materials were taken as graphite, Z = 6, rho = 1.67 g/cm^3; plexiglas, $Z_{effective}$ = 6.47; rho = 1.19 g/cm^3; paraffin, $Z_{effective}$ = 5.45, rho = 0.88 g/cm^3. The values found were in agreement for Z but substantially different for rho. (tr-auth)

15859 WHERE STANDS NONDESTRUCTIVE TESTING OF CONCRETE AND WHITHER. Li, S. T.; Ramakrishnan, V.; Russell, J. E. Int. J. Nondestruct. Test.; 2: 281-300(Dec 1970).

A review of the current status of methods for nondestructive testing of concrete is presented. Information is included on ultrasonic testing, instrumentation, radiography, radiometry, microwave testing, electric methods, and hardness methods. (J.R.D.)

15860 NONDESTRUCTIVE DETERMINATION OF ^{235}U DISTRIBUTION BY FIXED-POSITION GAMMA SCANNING. Richardson, Paul J.; Berner, Dale C. (Plum Brook Station, Sandusky, Ohio). Int. J. Nondestruct. Test.; 2: 253-9(Dec 1970).

A nondestructive method for determining fuel density variation in small, unirradiated, clad uranium dioxide (UO_2) plates is described. Instead of scanning a plate moving past a detection system, a plate is scanned at fixed positions. Where it is not possible to analyze the whole plate, variations are calculated by statistical sampling. A 2% variation could be detected at the 99.9% confidence level with the specimens. (auth)

15861 SIMPLIFIED OVERPRESSURE ANALYSIS OF THE WALLS OF A CYLINDRICAL PRESTRESSED CONCRETE PRESSURE VESSEL. Koerner, R. J. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Eng. Design; 14: 293-307(Nov 1970).

A way is suggested to determine the response of the walls of a cylindrical prestressed concrete pressure vessel (PCPV) when subjected to increasing cavity pressure. The adoption of any assumed mode of behavior is not required. A progressive solution is applied that takes into account the changes in vessel structural properties which occur when concrete cracks and embedded steel yields. The theoretical basis of the method, together with a worked example showing the application of the method, is given. In addition, the method is used to calculate the response of a vessel which had been tested; these results are compared with the experimentally recorded values. (auth)

15862 DETERMINATION OF THE EXPOSURE TIME IN INDUSTRIAL RADIOGRAPHY. Nastase, Marin. Constr. Masini; 22: 208-11(Apr 1970). (In Rumanian).

Nondestructive radiographic testing methods require a high-quality and excellent image to detect flaws; at the same time the exposure must be kept short to increase the productivity. The formula developed by Brachet which correlates the exposure time with the density of the developed film, the linear attenuation coefficient, the thickness of the specimen, the characteristics of the film and the radiation, the activity of the source and the distance between the source and the film, is examined. Practical examples are given for calculating the exposure time for x-ray

machines, ^{192}Ir, and ^{60}Co sources. The improved technique yields better results and saves time and material. (JPRS)

Protective Structures

15863 ZASHCHITA OT PRONIKAYUSHCHEI RADIATSII YADERNOGO VZRYVA. (Shielding Against Ionizing Radiation from Nuclear Explosions). Kukhtevich, V. I.; Goryachev, I. V.; Trykov, L. A. Moscow; Atomizdat (1970). 192p.

An engineering method for calculating the efficiency of protective equipment as shielding against ionizing radiation from nuclear explosions is presented. The characteristics of nuclear explosion-produced ionizing radiation are discussed with emphasis on the neutron field, gamma radiation, and fallout in the ground-level atmosphere. The shielding properties of typical protective media of different geometries are described. 123 references. (tr-auth)

Radioactive Material Handling

Refer also to abstracts 15723, 15850, 15916, 16153, and 16202.

15864 (CONF-700549-1) SAFE TRANSPORT OF FISSILE AND RADIOACTIVE MATERIALS. Edgerton, James H. (Army Transportation Engineering Agency, Fort Eustis, Va.). [1970]. 9p.

From Meeting of Society of Automotive Engineers, Detroit, Mich.

The transport of increasing amounts of Army fissile and radioactive materials in the U. S. is presenting many technical problems because of the hazards associated with their movement. It is essential that criteria, guidance, and performance standards be established for transportation to facilitate safety during movement of these materials by all modes. The basic considerations in the transportation of fissile and radioactive materials are that they may present hazards to the health and safety of the transportation workers, passengers, people along the right-of-way, and the general public. Complying with all countries' regulations will provide for the control of these potential hazards by considering three basic factors: relative hazard potential of these items or materials, packaging performance standards, and the transportation environment expected. These regulations will be used during the research, development, test, and evaluation stages to meet the requirements for normal conditions of transportation and also on the environmental conditions that they might encounter during an accident. Packages and containers for hazardous materials will be designed and constructed to ensure safety during transportation by providing adequate containment, lifting devices, tiedown devices, blocking, bracing, and slinging and structural requirements. Also, criticality and shielding and heat decay will be considered if fissile and large quantities of radioactive materials are to be transported. Adequate procedures will be provided to assure that the determination and control required by these regulations are accomplished. Results from accidents, possible effects following release of radionuclides, and some suggestions for reducing the probability of an accident are discussed. Definitions, significant and extensive changes to federal regulatory agencies regulations, and health physics aspects of radiation control are thoroughly explored. Future plans for improving safety during transportation are proposed. (auth)

15865 (NP-18574) HOMOGENEOUS INCORPORATION OF EUROCHEMIC MEDIUM LEVEL WASTE AND HIGH ENRICHED WASTE CONCENTRATE INTO BITUMEN. Hild, W.; Eschrich, H.; Galan, R. Garcia; Gulbrandsen, R.; Tallberg, K. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Sep 1970. 109p. (ETR-264). Dep. NTIS (U. S. Sales Only).

Activities directed to the definition of the chemical pretreatment flow-sheet for different intermediate-level waste streams, prior to the incorporation into blown bitumen, are described. The explosion risks and the definition of safety margins both with regard to operation conditions and waste composition were investigated. Studies of the safety aspects related to the radiolytic integrity of the solidified waste products are described, and solutions of problems, especially the selection of the optimal screw extruder lay-out for the bituminization are reported. A description of the Eurochemic solidification plant project utilizing homogeneous incorporation into blown bitumen is included. Plant start up is scheduled for 1973. (auth)

15866 (NP-18575) VERIFICATION OF REACTOR BURN-UP AND PLUTONIUM CALCULATIONS BY MEASUREMENTS IN A REPROCESSING PLANT. Bokelund, H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Sep 1970. 61p. (ETR-265). Dep. NTIS (U. S. Sales Only).

The independent verification of assessment data in the nuclear fuel cycle is of great interest for nuclear safeguards purposes. The verification of reactor calculations by measurements made on dissolved fuel in a reprocessing plant is described. For highly enriched uranium fuels the ^{235}U depletion calculated by the reactor on 16 different cores is compared with the ^{235}U depletion found from isotopic analyses of uranium. Values of α_5, the capture-to-fission cross-section ratio for ^{235}U, are also found from the measurements. For low enriched uranium fuels the reactor calculation of the burn-up on 14 different cores is compared with burn-up values found by measuring the change in the heavy element isotopic composition and by measurements of ^{148}Nd as fission indicator. The reactor estimate of plutonium is compared with the measured Pu/U ratio. The measured amounts of uranium are compared with the initial uranium amounts, corrected for burn-up, so as to verify input accountability measurements. For both types of fuel, coefficients of various relations between measured or derived parameters are tabulated for the purpose of characterizing fuels from a specific reactor for future recognition. (auth)

15867 (ORNL-TM-1312(Vol.9)) STRUCTURAL ANALYSIS OF SHIPPING CASKS. VOL. 9. ENERGY ABSORPTION CAPABILITIES OF PLASTICALLY DEFORMED STRUTS UNDER SPECIFIED IMPACT LOADING CONDITIONS. Davis, F. C. (Oak Ridge National Lab., Tenn.). Feb 1971. Contract W-7405-eng-26. 92p. Dep. NTIS.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

Results of an investigation to determine the energy absorption characteristics of plastically deformed inclined struts under impact loading are summarized. This information is needed to provide a usable method by which designers and analysts of shipping casks for radioactive or fissile materials can determine the energy absorption capabilities of external longitudinal fins on cylindrical casks under specified impact conditions. A survey of technical literature related to experimental determination of the dynamic plastic behavior of struts revealed no information directly applicable to the immediate problem, especially in the impact velocity ranges desired, and an experimental program was conducted to obtain the needed data. Mild-steel struts with rectangular cross sections were impacted by free-falling weights dropped from known heights. These struts or fin specimens were inclined at five different angles to simulate different angles of impact that fins on a shipping cask could experience under certain accident conditions. The resisting force of the deforming strut was measured and recorded as a function of time by using load cells instrumented with resistance strain gage bridges, signal conditioning equipment, an oscilloscope, and a Polaroid camera. The acceleration of the impacting weight was measured and recorded as a function of time during the latter portion of the testing program by using an accelerometer attached to the drop hammer, appropriate signal conditioning equipment, the oscilloscope, and the camera. A digital computer program was prepared to numerically integrate the force-time and acceleration-time data recorded during the tests to obtain deformation-time data. The force-displacement relationships were then integrated to obtain values of absorbed energy with respect to deformation or time. The results for various fin specimen geometries and impact angles are presented graphically, and these curves may be used to compute the energy absorption capacity of a longitudinal fin on a shipping cask as a function of its geometry and the percentage of deformation it is expected to experience as well as the peak force to which the fin would be subjected during the impact resulting from a 30-foot free drop onto an essentially unyielding horizontal surface. (auth)

15868 (ORNL-TM-3232) ANALYSIS OF THE DIFFUSION OF RADIOACTIVITY FROM ENCAPSULATED WASTES. Bell, M. J. (Oak Ridge National Lab., Tenn.). Feb 1971. Contract W-7405-eng-26. 21p. Dep. NTIS.

The leaching of radioactive nuclides from encapsulated wastes has been investigated using Fick's laws of diffusion. The loss rates of activity are dependent on a single dimensionless parameter ($L/R^2\lambda$), which can be interpreted as the ratio of a characteristic time for radioactive decay to a characteristic time for diffusion. For small values of this parameter, it is possible to approximate the exact solution to the diffusion equation for a particular geometry by the solution for diffusion in a semi-infinite medium. This asymptotic solution is shown to be valid for all feasible experimental and actual disposal conditions for which the diffusion model applies. Thus the fraction of the initial activity present in the environment at any instant of time is given by diffusion theory as $(2F/V)(\sqrt{Lt/\pi})(e^{-\lambda t})$, and the total amount of activity released over all time is given by the expression

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$(FA_0/V)\sqrt{L/\lambda}$. The time of maximum activity of an isotope of half-life $t_{\frac{1}{2}}$ in the environment is found to occur at 0.721 $t_{\frac{1}{2}}$ after disposal, and the activity present at this time will represent 48% of all the activity which will be lost from the matrix by diffusion. (auth)

15869 (ORNL-TM-3301) PUBLICATIONS OF THE RADIOACTIVE WASTE DISPOSAL SECTION, HEALTH PHYSICS DIVISION. Cowser, K. E. (comp.) (Oak Ridge National Lab., Tenn.). Feb 1971. 36p. Dep. NTIS.

The published literature and reports listed are current through July 1970. Reports issued earlier than 1955 are not included. About 258 references are listed. (J.R.D.)

15870 (SRO-153) GUIDE FOR FABRICATING AND HANDLING ^{252}Cf SOURCES. (Savannah River Operations Office (AEC), Aiken, S. C.). Jan 1971. 67p. Dep. NTIS.

A review is presented of the radiation and decay properties of californium-252, health physics procedures for working with ^{252}Cf, routine handling techniques for sealed sources and for unencapsulated ^{252}Cf, shielding requirements, containment and ventilation requirements, packaging and labeling requirements for shipping containers, purification techniques, ^{252}Cf product description, and the techniques and facilities at Oak Ridge National Laboratory and Savannah River Laboratory for fabricating and testing encapsulated sources. (auth)

15871 CONSIDERATIONS ON METHODS FOR CHECKING TIGHTNESS OF PACKAGE FOR RADIOACTIVE MATERIALS. Birkigt, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Isotopenpraxis; 6: 277-84(Aug 1970). (In German).

Leakage is defined and methods for checking tightness are summarized. The applicability of the methods for checking the tightness of packages for radioactive material is discussed. To detect leakage within the range recommended for A- and B-type packages, tightness checking through halide leak detectors, helium leak detectors, ^{85}Kr, gas bubble test, or pressure rise method are the most suitable approaches. (auth)

15872 IMPROVEMENTS IN AND RELATING TO A VESSEL FOR A RADIOACTIVE SUBSTANCE. (to Commissariat a l 'Energie Atomique). British Patent 1,220,035. 20 Jan 1971. Priority date 28 Feb 1968, France.

A vessel is described to contain an ion exchange material in a granular state on which a radioactive substance can be absorbed. The vessel comprises an annular chamber to house the ion exchange material having an inlet and outlet, a radiation shield surrounding the chamber, and a heating conduit. (J.R.D.)

15873 CHANGES IN THE PROPERTIES OF BASALT DURING SOLIDIFICATION OF HIGH-LEVEL WASTE PRODUCTS. Saidl, J.; Ralkova, J. (Nuclear Research Inst., Rez, Czech.). Silikaty; 14: 171-81(Apr 1970). (In Czech).

Molten basalt was selected for the solidification of high-level waste products. The high concentration of non-active salts in the waste solutions, however, changes the properties of basalt. The salts are mostly dissolved metal coatings of fuel elements, and also salts resulting from neutralization of acids used to dissolve the fuel material. The role of some modificating agents is evaluated, and other possible procedures for the processing of high-level waste products are considered. (auth) (INIS)

15874 RELATION OF CONCENTRATION DECREASE OF NUCLEAR AEROSOLS TO AEROSOL PROCESSES. Schikarski, W.; Wild, H. (Kernforschungszentrum, Karlsruhe, Ger.). Staub; 30: 251-5(Jun 1970). (In German).

An aerosol-model that describes the activity released from a nuclear power plant was developed. The time function and the dependence of activity transport on aerosol processes are important. Experiments with UO_2 aerosols are described. The aerosols were produced by the exploding wire technique in two different volumes of 2.2 m^3 and 0.02 m^3. The particle concentration was measured by a laser aerosol spectrometer over several days. Also, experiments were carried out at higher gas temperatures. A first quantitative approach is discussed and correlated between the decrease of concentration with possible aerosol processes, such as coagulation, diffusion, sedimentation, and convective transport. (INIS)

15875 MANIPULATOR MOTION LOCK (6 Aug 1970) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-2056).

2 drawings

A rapidly actuated and released motion-lock mechanism is described, which is used with Model 7 over-the-wall master-slave manipulators and is easily adapted to other manipulator models. The mechanism employs compressed-air-driven short-stroke pistons to supply the locking motion. Activation time for the locks to engage is $\sim 1/10$ sec, and release time is $\sim 3/10$ sec. The locks are controlled by the normal selector switch trigger mounted on the master hand. Motions are rigidly locked or released with one simple finger movement by the operator. The following subassemblies comprise the motion-lock units: disc-brake unit attached to the master-pivot casting to lock y-motion, disc-brake unit and cable clamp unit attached to the axial through-tube to lock x- and z-motion, and a cable-clamp unit mounted near the upper pulley bank to lock elevation twist and tong movements (E. T. and T.) generated by differential motion in the five wrist-joint cables. A large-dia, short-stroke, light-weight air piston is used with each movement. The motion-lock units employ chevron-type air seals on the piston groove. In the disc-brake units, the cylinder is free-floating in its mounting. Twin springs between the shoes of the disc-brake units force the shoes apart when the air pressure on the piston is removed. The shoes retract from the disc thereby eliminating frictional drag. A similar approach is used on the cable clamp for E. T. and T. movements. Twin springs force the gripping fingers away from the compression bar ensuring adequate clearance between the cable and clamping fingers and the compression bar. The cylinder is suspended from the tie-bar tube between the master- and slave-pulley banks and the pin through the upper row of pulleys. Suspension points are fitted with ball bearings to eliminate friction from the cylinder bracket. Lead counterweights compensate for the mass added to the pulley-bank area. The z-motion clamp on the through-tube is mounted and driven in the same manner but the piston is smaller because of the reduced pressure required. All cylinders are manifolded in parallel with light-weight rayon reinforced neoprene hose. Pressure is applied by deactivating a 110 V solenoid valve. Loss of electric power locks the manipulator. Circuitry of the manipulator is 6 V ac. This power activates two solenoids which control the air solenoid. Air at 100 psig pressurizes all brake systems. The small air volume downstream of the control solenoid ensures a fast response. The stroke of the air cylinder is $\sim 3/16$ in. These motion-lock mechanisms pay for themselves in time saved, they help prevent error, and they increase the efficiency of the operating staff. (For details see TID-4100 Suppl. 62) (F.S.)

Vacuum Engineering

15876 SAFETY AIR-LOCK USED FOR SAMPLE INTRODUCTION INTO A HIGH VACUUM TANK. Salle, M. H. (Univ., Clermont-Ferrand, France). Vide; 25: 203-6(Jul-Oct 1970). (In French).

The principles and the development of an air-lock enabling the introduction of small samples of material into a heavy ion beam and its withdrawal without significantly disturbing the 10^{-6} torr vacuum in the installation is described. A list of possible applications is given. (auth) (France)

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INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 16182, 16183, and 16184.

General Detectors and Monitors

Refer also to abstracts 15718, 15789, 15951, 15973, 15992, 16188, 16212, 16275, 16278, 17257, 17294, 17619, 17774, and 18248.

15877 (AD-713633) EXPERIMENTS ON GENERAL RELATIVITY AT LIQUID HELIUM TEMPERATURES AND IN ZERO MAGNETIC FIELDS. Final Technical Report, February 1964–November 1969. Fairbank, William M.; Hamilton, William O. (Stanford Univ., Calif.). Jul 1970. Contract AF33(615)-1204. 36p. (ARL-264). NTIS.

Research was performed on a free precession nuclear gyroscope. A description of the proposed gyroscope is given. The technical progress toward such a device is discussed. (auth)

15878 (ANL-7760(Pt.1), pp 28-32) ANALYSIS OF THE RESPONSE OF Ge(Li) AND Si(Li) DETECTORS TO THE 46.5-keV GAMMA RAY OF ^{210}Pb. Eckerman, K. F.; Kastner, Jacob (Argonne National Lab., Ill.).

From Radiological Physics Division annual report.

Ge(Li) and Si(Li) detectors were evaluated as potential detectors for in vivo measurements of ^{210}Pb. An analytical approach to the evaluation was developed which leads to optimization of the signal-to-background ratio and thus provides the experimenter with information upon which to base selection of a detection system. (auth)

15879 (ANL-7760(Pt.1), pp 57-66) ABSOLUTE SLOW NEUTRON MEASUREMENTS WITH SOLID STATE TRACK RECORDERS. Congel, F. J.; Roberts, J. H.; Armani, R. J.; (and others) (Argonne National Lab., Ill.).

From Radiological Physics Division annual report.

It is shown that measurements with mica as a recorder of slow-neutron induced fission events from thick (0.125 mm) natural uranium or thin (<100 $\mu g/cm^2$) enriched uranium (93.2% ^{235}U) provide comparable accuracy to gold-foil activation. It is also shown that background-free mica can be obtained. The electronic track counting method of Cross and Tommasino looks promising for the measurement of extremely small neutron fluxes. (auth)

15880 (ANL-7760(Pt.1), pp 67-73) LIQUID SCINTILLATOR ANALYSIS OF NEUTRON SPECTRA. Liu, J. S.; Oltman, B. G. (Argonne National Lab., Ill.).

From Radiological Physics Division annual report.

The organic scintillator (e.g., NE-213) is a high efficiency detector for fast neutrons. Such a detector has been used to study the cosmic ray neutron flux (1 to 10 MeV), and also the energy spectra of two common neutron sources (^{241}Am–Be and ^{244}Cm fission neutrons). The limitations and effects associated with volume and configuration of such a system are described. (auth)

15881 (BNWL-B-41) USE AND CALIBRATION OF THE AUTOMATIC COLUMBIA RIVER MONITORING STATION IODINE MONITOR. Fisher, W. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec 1970. Contract AT(45-1)-1830. 25p. Dep. NTIS.

Columbia River water is pumped from 135 feet offshore through the nominally 200 gallon ACRMS tank. Two detectors measure radioactivity in water flowing through the tank. This document concerns primarily the Iodine Monitor, whose NaI(Tl) detector is submerged in the tank, and describes in more detail the use and calibration of that instrument. Also, the iodine-131 response of the Gross Gamma Monitor, which utilizes a 3 inch diameter by 3 inch thick bioplastic scintillator located just above the surface of the water, is discussed briefly. Previously reported calibration data and operating instructions for the Iodine Monitor are superseded by this document. (auth)

15882 (CEA-R-4009((1)) NORMALIZATION OF TESTS FOR DETECTORS MEASURING EXTERNAL IRRADIATION. I. DETECTORS FOR MEASURING EXTERNAL IRRADIATION BY MEANS OF ELECTROMAGNETIC RADIATIONS. (Commissariat a l'Energie Atomique, Paris (France)). Dec 1970. 115p. (In French). Dep. NTIS (U. S. Sales Only).

The normalized procedures used in the Radioprotection Divisions of the C.E.A. for standardizing and determining the spectral sensitivities of detectors for measuring external irradiation by electromagnetic radiation are described. Standardization involves the reference detector and the reference radioactive source. The following factors concern spectral sensitivity measurements: reference detector; the reference radioactive sources used; and the use of x ray generators (fluorescence or filtration). The technical details of the reference detector and those of a widely used detector (Babyline) are given. (auth) (France)

15883 (CEA-R-4119) MEASUREMENT OF NEUTRON FLUX BY THE FLUCTUATION METHOD. Plaige, Yves; Vaux, Christian; Lyscar, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1970. 68p. (In French). Dep. NTIS (U. S. Sales Only).

The method consists of measuring the variance in the neutron detector signal fluctuations. It is shown that if the distribution of neutron events obeys a Poisson law, then the variance in the fluctuating signal is proportional to the neutron flux (Campbell Theorem). Assuming the statistical nature of the measurement principle is known the method will only be used in relatively intense flux (where the number of events is high) with in-core or out of core detectors. Its most important advantage is its enhanced power of discrimination between neutron flux and gamma radiation; a disadvantage is that the response time is long. The method is complementary to existing methods, but does not supersede them. The circuits developed and the various parts which constitute the new instrumentation are described. (auth) (France)

15884 (EUR-4567) DEVELOPMENT OF A SCINTILLATION DETECTOR FOR FAST ION COUNTING IN A MASS SPECTROMETER. Tasman, H. A. (European Inst. for Transuranium Elements, Karlsruhe (West Germany)). 1970. 30p. Dep. NTIS (U. S. Sales Only).

A description is given of a scintillation detector, designed for fast counting of 3 keV heavy ions. It applies intermediate acceleration to the incident ions to permit reliable operation with 60 kV conversion voltage. The pulse-height spectrum measured at the detector output allows the estimation of the counting efficiency as well over 95% with a background of only 3 counts per second. An experimental correction formula for counting losses, based on a dead time of 25.2 ns, together with additional corrections at very high as well as at very low counting rates, seems to hold up to about 5 MHz. However, in spite of apparently correct performance, isotope ratios measured show a scatter of ±1%, which is two to three times the scatter from a standard open-multiplier detector. The origin of the scatter could not be traced. In the present state, the scintillation detector should not be preferred for measurement of ion beams of more than 10^{-15} A since the standard multiplier offers a better reproducibility at lower complexity and cost. (auth)

15885 (LUSY-6903) A SIMPLE METHOD FOR THE CONSTRUCTION OF STRIP LIGHT-GUIDES. Dougan, Peter; Kivikas, Toeivelemb; Lugner, Kjell; Ramsay, Wilhelm; Stiefler, Werner (Lund Univ. (Sweden). Dept. of Physics). Jul 1969. 16p. Dep. NTIS (U. S. Sales Only).

A method for preparing strip light-guides for use in a scintillation counter hodoscope is described. The preparation method is based on softening large-volume pieces of Plexiglas by immersion in hot mineral oil. (Sweden)

15886 (NP-18661) LOW LEVEL TRITIUM MEASURING SYSTEM. Kanter, Michael (Technion-Israel Inst. of Tech., Haifa). Mar 1967. 58p. (In Hebrew and English). Dep. NTIS (U. S. Sales Only).

Thesis.

The system described in this work is used in tracer measurements of biological processes. The main limiting factors in such measurements are the pulses due to the thermionic emission from the photocathode of the photomultiplier which are in the energy range of the β radiation to be measured. The number of these noise pulses is very large in comparison to source pulses; the system developed reduces the thermionic noise to a level which enables measurement of tracer activities to be carried out in a short time. The main parts of the system are the photomultipliers, the discriminators, and the coincidence circuit. The photomultipliers used have a noise lower by a factor of 50 compared to usual photomultipliers. The discriminators and coincidence circuit were built only of tunnel diodes. It was possible to achieve a background of about 30 cpm, due chiefly to external radiation. Tritium activities down to 0.1 mμc were measured in times not exceeding 5 minutes with a fractional standard deviation σ_s/n_s of 10%. (R.W.R.)

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15887 (TID-25651) VARIATIONAL APPROACH FOR THE DETERMINATION OF NEUTRON FLUX SPECTRA FROM DETECTOR ACTIVATION. Brandon, Robert William (Tennessee Univ., Knoxville). Mar 1969. 69p. Dep. NTIS.

Thesis.

Through the use of a variational approach and a transport theory description of the system, an expression was derived which relates detector activity to the unperturbed neutron flux and the adjoint difference flux. The equation was cast in S_n formalism to permit numerical solution. The self-contained adjoint problem was solved using standard S_n schemes. The unperturbed flux was expanded as a series of Laguerre polynomials, the coefficients of which were determined through inversion of the resulting rectangular matrix. The theoretical model was examined through application to several synthetic problems. In the first analysis, the inversion scheme was investigated in a problem involving a Maxwell-Boltzmann spectrum in which there was no detector perturbation to the neutron flux. Good agreement was obtained with little dependence on the order of expansion of the unperturbed flux. In the second analysis, a water-moderated spectrum was examined with both perturbed and unperturbed calculations. Direct calculation of perturbed activities showed good agreement with standard activity calculations. Comparable calculations of flux spectra with perturbed and unperturbed activities showed close agreement. The flux spectrum calculations yielded good results in the thermal energy range, and analysis showed that difficulties encountered in the epithermal range were due to the polynomial expansion scheme, as has been previously observed. (auth)

15888 SILICON NUCLEAR PARTICLE DETECTORS PRODUCED BY ION-IMPLANTATION TECHNIQUES. Chwaszczewska, Janina (Inst. of Nuclear Research, Swierk, Poland); Lechowicz, Tadeusz; Lazarski, Stanislaw; Ondrusz, Ewa. Nukleonika. 15: 317-22(1970). (In Polish).

Boron and phosphorus ions were implanted into n-type silicon using a mass separator. Silicon nuclear particle detectors of high stability and very good spectrometric properties were obtained, and their characteristics investigated. (auth)

15889 ELECTRON-INDUCED LUMINESCENCE IN RADIATION STANDARDS OF TRITIUM AND RADIOCARBON IN ACRYL PLASTICS. Prydz, S.; Koren, J. F.; Melo, T. B. (Univ. of Oslo). Int. J. Appl. Radiat. Isotop.; 21: 629-30(Oct 1970).

Warning against temperature-dependent effects when using polymethylmethacrylate (PMM) β standards in autoradiography is given. The relative importance of film blackening by the electron and by the light components of such standards depends on whether tritium or radiocarbon is considered. A method of reducing the unwanted light effect is suggested. (UK)

15890 SIGNAL PROPERTIES AND NEUTRON-GAMMA RATIO FOR THE DETERMINATION OF THERMAL NEUTRON FLUX DENSITY BY SURFACE-BARRIER SEMICONDUCTOR DETECTORS. Graul, J.; Ruge, I. (Technische Hochschule, Munich). Nucl. Instrum. Methods; 91: 97-101(1971). (In German).

The following signal properties of a semiconductor neutron detector are calculated: the radiation induced current due to alphas from the neutron-alpha-conversion layer (boron), the disturbing signal due to gamma background radiation and the neutron-gamma-ratio. Parameters are the width of the pn-junction x_d and the thickness of the n,α-conversion layer x_b. Isotropy of the radiation and the energy distribution of the in-core gamma flux are taken into account. It is shown that the neutron-gamma-ratio increases with decreasing x_d up to a maximum value and that the design of the detector under the aspect of higher radiation resistance with respect to conversion alphas causes a low neutron-gamma-ratio or small neutron generated currents. (auth)

15891 ESTIMATION OF PHYSICAL PARAMETERS WITH THE BAYES PRINCIPLE. EXAMPLES FROM THE NUCLEAR RADIATION MEASUREMENT TECHNIQUE. Weise, Lothar (Kernforschungsanlage, Juelich, Ger.). Atomkernenergie; 16: 233-6(1970). (In German).

This work deals with a method for statistical estimation of physical parameters which may be called a classical one because of their first appearance long before the introduction of the usual present methods, as for example the Maximum Likelihood Method or the Least Squares Fit. The method discussed is based upon the Bayes Principle and will be called Bayes Estimation. The application of Bayes Principle for estimating parameters was not always correct in the past. This fact leads to a great deal of controversy in statistical literature. In recent time Bayes Estimation has found many distinguished defenders. There are important examples for their application in nuclear radiation measurement technique. (auth)

15892 DETECTION OF TRITIUM RADIATION BY MEANS OF AN OPEN COUNTER CONTAINING DAMPING VAPOR OVER FREE SURFACE OF THE LIQUID. Jarnuszkiewicz, Andrzej; Pietrzak, Ryszard; Rozenfeld, Bronislaw. Nukleonika; 15: 189-95(1970). (In Polish).

An open, self damping counter has been used for detection of tritium radiation from water solutions of T_2O. The recording rate of the counter is proportional to the specific activity of the radioactive solution. It has been found that the efficiency for the edge type counter is 3.5 per cent. (auth)

15893 SEMICONDUCTOR LINEAR AMPLIFIER FOR USE IN SPECTROMETRY. Olejniczak, Wieslaw; Zabierowski, Janusz (Univ., Lodz, Poland). Nukleonika; 15: 197-202(1970). (In Polish).

A semiconductor linear pulse amplifier with the FET preamplifier is described. Input resistance of the preamplifier is 120 MΩ, and the gain factor is 3000. Integral nonlinearity of the gain factor up to the output amplitude 8 V is less than 1%. Thermal gain drift of the preamplifier and amplifier in the temperature range +20 to +40°C is −0.05%/°C and +0.05%/°C, respectively. (auth)

15894 EXPERIMENTAL ANALYSIS OF THE RESOLUTION OF PROPORTIONAL COUNTERS. Pawlowski, Zdzislaw; Walentek, Jan (Katedra Radiologii Politechniki Warszawskiej, Warsaw). Nukleonika; 15: 463-76(1970). (In Polish).

An experimental method of measuring the proportional counter's energy resolution is presented. The effect of the electrical noise and complex structure of spectral lines on the results is taken into account. The dependence of the energy resolution and the avalanche fluctuation on the supply voltage were measured for proportional counters made in Poland (PXA Be 36/52, PX Kr Be 36/52, PX Xe Be 36/52). The avalanche fluctuations were obtained for Fano coefficients previously calculated. (auth)

15895 ULTIMATE RESOLUTION OF PROPORTIONAL COUNTERS. Pawlowski, Zdzislaw (Warsaw Polytechnic Inst.). Nukleonika; 15: 203-13(1970). (In Polish).

The use of gaseous mixtures in which second collisions lead to reduced W and Fano coefficients to fill proportional counters is proposed. It is shown that these mixtures may be used to obtain a better energy resolution. (auth)

15896 DETECTORS OF RADIATION AND THEIR APPLICATION TO THE INVESTIGATIONS OF COSMIC SPACE. Lipinski, A.; Mycielski, W. (Technical Univ., Lodz, Poland). Postepy Astronaut.; 3: 93-106(1969). (In Polish).

The operating principles of basic types of radiation detectors as well as their general properties are described. The usefulness of some kinds of detectors for cosmic ray measurements is discussed. Also, examples of particular application of detectors for cosmic vehicles for cosmic space investigations are given. (auth) (NSA of Poland)

15897 FINITE SOLID ANGLE CORRECTION FACTORS FOR GAMMA-RAYS USING THRESHOLDS IN THE PULSE HEIGHT DISTRIBUTIONS. Waibel, E.; Grosswendt, B. (Physikalisch-Technische Bundesanstalt, Brunswick). Nucl. Instrum. Methods; 91: 231-6(1971).

Attenuation factors due to finite solid angle in angular-correlation measurements were studied with respect to the influence of shielding and of defined thresholds in the pulse-height spectra for a (dia. 7.62 cm × 7.62 cm) NaI(Tl) scintillation counter. Characteristic discrepancies were found in the gamma-ray energy range from 0.51 MeV to 6.1 MeV by comparing the experimental values with the calculated attenuation factors from total gamma-ray attenuation coefficients. (auth)

15898 LUMINESCENCE SPECTRA OF LIQUID ORGANIC SCINTILLATORS. Langenscheidt, E. (Kernforschungsanlage, Juelich, Ger.). Nucl. Instrum. Methods; 91: 237-45(1971).

The optical luminescence spectra of some common scintillation systems are compared for different modes of excitation (α, β, γ radiation and ultraviolet light. Information about experimental factors which influence the shape of the spectra (especially self-absorption phenomena) and aspects of the mechanism of the scintillation process was obtained. The intensity of fluoresence light was measured—using a modified Cary 14 recording spectrophotometer—with a multiplier phototube as detector so that spectral analysis of light intensities of about 10^{-4} lumen could be carried out. This mode of detection has advantages compared with photographic registration. The resolution obtained experimentally was better than the inherent resolution of the luminescence spectra. The comparison of the various modes of excitation indicated identity of the spectra relative to the spectral intensity of the bands as

well as to their spectral position (tolerances were 7% for intensity and 1% for the wavelength position). (auth)

15899 COMPUTER CONTROLLED MULTICOUNTER EXPERIMENT. Pozar, F. (Frieseke and Hoepfner GmbH, Erlangen, Ger.). Nucl. Instrum. Methods; 91: 253-65(1971).

A computer-controlled multicounter experiment is described. The arrangement of the closed loops, data way, experimental electronics, the electronics which analyzes the parameters, and the CAMAC interface is discussed. (auth)

15900 COMPARISON OF DETECTORS USED IN MEASUREMENT OF 10 TO 300 keV X-RAY SPECTRA. Israel, H. I.; Lier, D. W.; Storm, E. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods; 91: 141-57(1971).

X-ray spectral measurements in the energy range 10 to 300 keV were made using four detectors (sodium iodide crystal, germanium and silicon semiconductors, and xenon proportional counter). The measured spectra are compared. The resolution of each detector was measured, and its effect on the continuum and on the characteristic L and K lines of the target is discussed. The results of Monte Carlo calculations of photopeak efficiency, escape-peak losses, and the Compton distribution for each detector are presented. The distortion of incident monoenergetic lines is shown for each type of detector. The region of usefulness of each detector is discussed, and an iterative method which utilizes all four types of detectors to deduce the true incident spectrum is described. (auth)

15901 PULSE SHAPES FROM SCINTILLATION COUNTERS. Frohlich, A. (Tel-Aviv Univ., Israel). Nucl. Instrum. Methods; 91: 169-71(1971).

Discrepancies were found in the signal-to-noise ratio of pulse-height spectra of muons in a scintillation counter that were measured by different methods. These arose from the different shapes of pulses from the intrinsic noise of the photomultiplier and the actual scintillation pulses. (auth)

15902 CONTRIBUTION TO THE CALCULATION OF OPTIMUM RADIATION CONDITIONS AND MEASUREMENT OF RADIOACTIVITY IN ACTIVATION ANALYSIS. Fedoroff, M. (Centre d'Etudes de Chimie Metallurgique, Vitry/Seine, France). Nucl. Instrum. Methods; 91: 173-87(1971). (In French)

The limit of detection in activation analysis depends on many variables that are chosen by the experimenter. The influence of irradiation, decay, and counting times and of the energy width chosen in a photoelectric peak is studied. After the limit of detection is defined, the formulas which allow the determination of the optimum values of the above variables as a function of the parameters imposed by the nature of the analysis are established. These optimum values are computed for the case of an isotope the radioactivity of which is measured in the presence of another radioisotope and a constant background. The variation of these optimum values is shown on a diagram as a function of the above parameters in a simple mathematical form. Experimental verification and examples of application are given. (auth)

15903 DEADTIME CORRECTION FOR PULSED BEAMS. Battleson, K.; McDaniels, D. K. (Univ. of Oregon, Eugene). Nucl. Instrum. Methods; 91: 295-6(1971).

A method is presented for making deadtime corrections for non-paralyzable electronic devices for the case of counting events from a pulsed beam of finite time spread and a counting interval which encompasses only a fraction of the interval between pulses. (auth)

15904 ELECTROMETERS FOR STANDARD IONIZATION CHAMBERS. Oppelt, Jiri (Czechoslovak Inst. of Metrology, Prague). Jad. Energ.; 16: 380-1(1970). (In Czech).

Various features of different electrometer systems for standard ionization chambers are compared. (auth)

15905 ON-LINE PARTICLE IDENTIFICATION USING THE TABLE LOOK-UP METHOD. Husimi, Kazuo (Tokyo Univ.). Jap. J. Appl. Phys.; 9: 1399-1404(Nov 1970).

The table look up method is applied to the on-line particle identification based on the range relationship proposed by Goulding to reduce the dead time caused by processing of the computer. Telescope E–DE semiconductor detectors are used. The quantizing error and the program technique are discussed. The particle identification spectrum, energy spectra of ^{3}He and alpha particles and the total energy spectrum are obtained with sufficient precision. The on-line particle identifier is advantageous in that, not only is it easy to handle, but it also has flexibility compared to the analog circuit particle identifier. (auth)

15906 MODEL FOR THE NONLINEAR RESPONSE OF PLASTIC SCINTILLATORS TO INTENSE WEAKLY IONIZING RADIATION. Lauzon, Alfred (Univ. of California, Livermore). Mol. Cryst. Liquid Cryst.; 11: 203-15(Oct 1970).

Plastic scintillators are less efficient for detecting heavily ionizing particles than for weakly ionizing fast electrons. Nonlinear behavior was observed on a macroscopic scale when the flux rate of electrons was sufficiently intense. A phenomenological model to explain the latter effect is presented. The model postulates that an ionizing particle absorbed in the fluor deactivates a volume surrounding the particle track. The affected volume recovers with a rate constant k. For 100 kV electrons in a beam j(t) electrons/cm^2-sec the fraction of the quenched fluor volume δ is found to be given by the expression $\delta = e^{-w}\int_0^t e^{w} j(t)dt$ where $w(E) = \int_0^t [\sigma j(t) + k]dt$ and $\sigma = (3.3 \pm 0.8) \times 10^{-13}$ cm^2, $k \sim 3 \times 10^3$ sec^{-1}. The fluorescence emission is $l = l_0[1 - \delta(t)]$ where $l_0 = sj_0$ and s is the limiting fluor efficiency as $j \to 0$. The susceptibility to quenching of the fluor used in this experiment is $G = 4.8 \times 10^{-14}$ g/MeV which is equivalent to 28,000 monomer units of styrene per 100 eV of energy absorbed. It is suggested that this effect may be due to excitons absorption by impurities in some local crystalline order. (auth) (UK)

15907 DEVELOPMENT OF NUCLEAR AND X-RAY DETECTORS. Ostrowski, Kazimierz W. Zesz. Nauk. Akad. Gorn.-Hutn. Krakow., Rozpr.; No. 208, 133-44(1969). (In Polish).

The development of proportional and GM-counters during the last 30 years at the Chair of Physics and Institute of Nuclear Techniques Academy of Mining and Metallurgy is described. (auth)

15908 PULSE-HEIGHT ANOMALY IN SILICON RADIATION DETECTORS. Key, James Roy. Houston, Tex.; Rice Univ. (1970). 157p. University Microfilms Order No. 70-23,538.

Thesis.

The pulse height behavior of a lithium-drifted silicon surface barrier radiation detector was investigated over the temperature range 4.2 to 291°K. When fields up to 10 kV/cm were applied to the detector, pulse height saturation was observed above 31°K for alpha particles. An accurate determination of ϵ, the average energy necessary to create an electron-hole pair, showed that ϵ_α at 31°K was 3.4% greater than the value at 291°K. The value of ϵ_α at 77.4°K was 3.67 ± 0.01 eV. Below 31°K high field data demonstrated that the conventional field extrapolation technique for determining ϵ is invalid. The presence of both slow and fast rise-time components in the detector pulse indicated that dielectric relaxation phenomena were not responsible for the decreased pulse height below 31°K. The variation of ϵ with the gap energy was shown to be linear above 31°K. (TSS) (Diss. Abstr. Int., B)

15909 SOME USES OF A BACK-TO-BACK FISSION CHAMBER. Rustichelli, F. (EURATOM, Ispra, Italy). Energ. Nucl. (Paris); 12: 413-16(Sep-Oct 1970). (In French).

Some uses of a back-to-back fission chamber in fission experiments and reactor physics are described. In particular it is shown that the back-to-back fission chamber can be used for measuring fission cross-sections, isotopic compositions of depleted uranium, fast fission ratios, the absolute neutron flux, fission yields, and the transmission of fission fragments. (auth) (France)

15910 ENERGY-LOSS MECHANISMS IN SEMICONDUCTOR RADIATION DETECTORS. Zulliger, Hans Rudolf. Stanford, Calif.; Stanford Univ. (1970). 226p. University Microfilms Order No. 70-18,513.

Thesis.

The energy-loss mechanism due to ionization is investigated in lithium-drifted silicon and germanium semiconductor radiation detectors. A simple phenomenological model is presented which accounts for the energy losses in the formation of an electron-hole pair (ϵ). Experiments were performed to measure the energy expended to produce a pair in silicon. Good agreement between theory and experiment was obtained for the absolute value of ϵ at room temperature and at 77°K in silicon. Good agreement between theory and experiment was also obtained in germanium. In order to determine absolute values of ϵ, it was necessary to study the charge collection losses due to charge trapping. A comprehensive investigation of the charge collection efficiency (η) resulted in equations which can be used to predict relative charge collection efficiencies as a function of photon energy and detector bias voltage. It was found that the charge collection efficiency is a function of the photoelectric absorption coefficient and thus is also a function of the incident photon energy. It is concluded that direct recombination processes can cause additional charge losses at low detector bias voltages. The statistical nature of the pair creation process results in a variation in output pulse heights of the detector signal and thus in a finite width of monoenergetic energy peaks. This line broadening effect is obscured by electronic noise and inefficien-

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cies in charge collection. A quadratic subtraction of the latter two terms from the total line width leads to the variance of the pair generation process. This variance, σ^2, is expressed by the Fano factor (F) and the standard deviation (E/ϵ) expected from a normal distribution, $\sigma^2 = F \times (E/\epsilon)$; F accounts for the fact that the ionization events are not independent. An evaluation of the Fano factor using the proposed model of ϵ for silicon and germanium resulted in F = 0.046 to 0.051 for both silicon and germanium. Finally, the most probable energy loss and energy-loss straggling are investigated in lithium-drifted silicon for electrons, positive pions, and protons with energies between 31.5 and 767.2 MeV. Very good agreement with theory is obtained with protons and pions. The electron data demonstrate effects which can be attributed to the absorption by the detector of a portion of the electron bremsstrahlung radiation. No apparent evidence for a predicted decrease in electron ionization through radiative corrections is observed (Tsytovitch effect). (TSS) (Diss. Abstr. Int., B)

15911 COMPUTERISED SCANNER FOR BIDIMENSIONAL RADIOCHROMATOGRAMS. Chain, E. B.; Lowe, A. E.; Mansford, K. R. L. (Imperial Coll. of Science and Tech., London). J. Chromatogr.; 53: 293-314(2 Dec 1970).

A computerized automatic scanner for the quantitative evaluation of paper radiochromatograms is described. In this instrument the paper chromatogram is held in a frame, vertically moveable, between two gas flow counters. The scanning operation is performed by moving the counters horizontally across the paper radiochromatograms, discontinuously exploring unit areas for programmed time periods, the period depending on the level of radioactivity. At the end of each line, the counters are made to return to their position of origin and simultaneously the radiochromatogram is moved vertically upwards to the next line of exploration. The coordinate positions, radioactive counts, and time for each unit area are recorded on paper tape. Control and read-out of the coordinate positions are effected photo-electrically, employing perforated code plates. A battery of up to ten scanners can be used simultaneously. The scanners are arranged in a time sharing system so that a single tape punch is used for all machines. The punch tape is processed using a programme which gives, for each machine, number map representation of the radioactive spots on the chromatogram, together with automatically computed spot totals of absolute radioactivity. Mechanical construction details and schematic electronic circuits are presented together with performance data. (auth)

15912 SIMPLE METHOD FOR MEASURING FAST NEUTRON FLUXES. Bruninx, E. (Philips Research Labs., Eindhoven, Netherlands). pp 250-7 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The proposed method uses a paraffin wax sphere with an indium foil at its center. The whole assembly is shielded by cadmium foil to cut off thermal neutrons. Depending on their initial average energy, the fast neutrons incident on the box are more or less thermalised and activate the indium foil via the (n,γ) reaction to ^{116m}In. The induced activity is directly proportional to the neutron flux. The response of the detector is given as a function of the average neutron energy. Calibration of the induced ^{116m}In activity with absolute neutron fluxes allows the direct measurement of an unknown neutron flux. A simple method is used to correct for the presence of low-energy back-scattered neutrons. The method is used to measure the neutron flux produced by 18 MeV deuterons on a thick beryllium target, in conditions where severe backgrounds of back-scattered neutrons prevail. (auth) (UK)

15913 ENERGY DEPOSITION SPECTRA OF ^{14}C BETA RADIATION IN A UNIFORM MEDIUM. Braby, L. A.; Roesch, W. C.; Glass, W. A. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Radiat. Res.; 43: 499-503(Sep 1970).

The effect of the gas–solid interface at the boundary of a proportional counter on the observed energy-deposition spectrum is not at present calculable. Therefore, the effect was measured in one case where it was practical to remove the solid wall from the detector by more than the range of the most energetic particle. A grid-walled proportional counter, 1 cm in diameter, with a removable ^{14}C-loaded lucite wall was suspended at the center of a spherical vacuum chamber 1.2 m in diameter. The chamber was filled with a ^{14}C-loaded, counting gas, equivalent to lucite in mass stopping power, at a pressure that resulted in an infinite homogeneous medium for the ^{14}C β particles around the counter. The energy deposition spectrum was recorded with and without the solid wall. For equal activity per unit mass in the solid and the gas, the dose must be the same with or without the solid wall. However, significant differences were found in the energy-deposition distributions. The presence of the solid wall caused more of the absorbed dose to be in the high-energy part of the spectrum with a compensating decrease at low energies. This result indicates that measurements of energy-deposition spectra should be made with gas-walled or other homogeneous detectors. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 15523, 15529, 17677, and 17678.

15914 (CEA-R-4131) MEASUREMENT OF $4\pi\ \beta-\gamma$ COINCIDENCES IN THE RADIOACTIVITY METROLOGY LABORATORY. DESCRIPTION, PERFORMANCE, AND APPLICATIONS TO COMPLEX LEVEL SCHEMES, ACCURACY OBTAINABLE IN PARTICULAR CASES. Laine, Michel; Perolat, Jean-Pierre; Bouchard, Jacques; Le Gallic, Yves (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan 1971. 81p. (In French). Dep. NTIS (U. S. Sales Only).

After describing the $4\pi\ \beta-\gamma$ coincidence unit, the different corrections are discussed for a simple decay scheme and then for the case of a complex decay scheme, paying particular attention to the correction terms peculiar to the unit. The different methods used to determine the γ efficiency of the $4\pi\ \beta$ detector were compared, and the practical aspects discussed. Several examples of complex decay scheme measurements are given (^{125}Sb, ^{59}Fe, ^{106}Ru + ^{106}Rh). The performance is discussed and suggests that an accuracy of 0.2 per cent is now feasible. (auth) (France)

15915 (DUN-M-30) OPERATOR'S MANUAL: BAIRD ATOMIC ENRICHMENT TESTER. (Douglas United Nuclear, Inc., Richland, Wash.). 4 Sep 1969. 17p. Dep. NTIS.

Operating procedures for the Baird Atomic enrichment tester are described. This system is used to determine the enrichment of uranium billets. The system consists of a spectrometer (model 530A), a Recti/Riter (model 975-126), and a NaI(Tl) crystal mounted on a photomultiplier tube. (R.W.R.)

15916 (GEAP-12114-3) PLANT INSTRUMENTATION PROGRAM. Quarterly Report No. 2, July–September 1970. Bishop, D. M.; Aitken, E. A. (comps.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Oct 1970. Contract AT(30-1)-68. 95p. (BHO-68-3). Dep. NTIS.

Technical efforts associated with the Plant Instrumentation Program were directed toward the evaluation and qualification of nuclear assay instrumentation in time for their application to upcoming fuel fabrication programs. The evaluation of assay instrument techniques on prepared fuel rod, scrap, and waste standards is in the final stages. Approximately 600 individual assay tests were performed with calorimeter, gamma (sodium iodide and germanium–lithium) and neutron (gross and coincident) instrumentation techniques. Plans were formulated for the application of selected instrumentation to fuel fabrication programs, including the nondestructive nuclear assay of input, process, and product output materials. (auth)

15917 (ORNL-tr-2415) SPECTRUM MEASUREMENTS OF RADIOACTIVE NEUTRON SOURCES IN THE 10-keV TO 10 MeV ENERGY REGION WITH PROTON-RECOIL PROPORTIONAL COUNTERS. Werle, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translated for Oak Ridge National Lab., Tenn., from report NP-18359. 106p. Dep. NTIS.

Proton recoil proportional counters have been used for several years with success for neutron spectrum measurements in the energy range between about 20 keV and 1.5 MeV. It is shown by measurements with monoenergetic neutrons and by comparison measurements with other methods, that with proton recoil counters reliable measurements are also possible below 20 keV and in the energy range between 1.5 and 10 MeV. The spectra of most of the normally used, radioactive neutron sources (α,n-sources: Ra–Be, Am–Be, Am–B, Am–B^{10}, Am–F, Am–Li, and Cf^{252} spontaneous-fission source) were measured in the whole interesting energy range, especially also in the range below 1 to 2 MeV; and the influence of the size of the radioactive particles on the neutron spectrum was proved experimentally. The differential neutron spectrum of a Sb–Be (γ,n)-source can be determined for the first time with good accuracy, in spite of the very high γ-background, by using the γ-n-discrimination technique. (58 references) (auth)

15918 (STI/PUB-275) INSTRUMENTATION FOR NEUTRON INELASTIC SCATTERING RESEARCH. Panel Proceedings Series. Proceedings of a Panel Held in Vienna, 1–5 December 1969.

(International Atomic Energy Agency, Vienna (Austria)). Oct 1970. 298p. (CONF-691220). IAEA $7.00.

Separate abstracts were prepared for 14 of the 15 papers presented. The remaining paper was previously included in NSA. (W.H.K.)

For abstracts of individual papers see: 15922–15930, 17677, 17678, and 18184–18186.

15919 AUTOMATIC SUPPLY SYSTEM OF THE ORANGE TYPE SIX-GAP MAGNETIC BETA SPECTROMETER. Bialkowski, Jacek; Burzynski, Zygmunt; Piotrowski, Antoni (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 15: 377-82 (1970).

A system is described that provides control of the time between the successive changes and the magnitude of the current step. It is equipped with an internal timer and can be controlled by an external device. The range of automatic operation is set at the 125, 250, and 500 current steps, and the time between the successive steps is regulated over the range from 1 second to 1 hour when an internal timer is applied. (auth)

15920 USE OF A TROCHOIDAL BETA-RAY SPECTROMETER AS AN INTERNAL PAIR SPECTROMETER. Allan, C. J. (Univ. of Manitoba, Winnipeg). Nucl. Instrum. Methods; 91: 117-23 (1971).

A trochoidal β-ray spectrometer has been constructed at the University of Manitoba. The use of the instrument as an internal pair spectrometer is discussed. A method of evaluating the pair detection efficiency is presented and the use of the instrument to study internal pair production in ^{85}Sr is discussed. (auth)

15921 SOME NEW APPLICATIONS OF NEUTRON SLOWING DOWN TIME SPECTROMETRY. Wakabayashi, Hiroaki; Sekiguchi, Akira; Nakazawa, Masaharu; Nishino, Osamu (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 487-99(Oct 1970).

A lead neutron slowing-down-time spectrometer LESP (LEad Standard Pile or LEad neutron SPectrometer) with a number of novel features was devised. It was applied to measurements on the effective sensitivity of counters and on the effective absorption and total cross sections of reactor materials. The basic principle of this method centers around the correlation that exists between the average neutron energy and the neutron slowing-down-time after fast neutrons are pulsed into a block of heavy medium with small neutron absorption such as a large lead assembly. This is analogous to the well established time-of-flight spectrometery. The proposed method of spectrometry should be suitable for measurement of such effects as the resonance self and mutual shielding and geometrical heterogeneity. As trial experiment, the effective efficiency of a ^{235}U fission chamber was measured and found to correspond fairly well with BNL-325 data. As another example, blocks of heavy resonance material such as natural uranium, antimony, and tungsten were placed in the LESP for producing the standard neutron spectrum fields of these materials, and the neutron spectra and effective cross sections measured on these materials were compared with calculation. It is concluded that these new applications of the method are quite practical for measurements of such properties as the effective efficiency of neutron counters and group averaged cross sections. (auth)

15922 CRITICAL COMPARISON OF TECHNIQUES FOR INELASTIC NEUTRON SCATTERING. Woods, A. D. B.; Dolling, G.; Cowley, R. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 1-17 of Instrumentation for Neutron Inelastic Scattering Research. Vienna; International Atomic Energy Agency (1970).

From Meeting on Instrumentation for Neutron Inelastic Scattering Research, Vienna, Austria. See STI/PUB-275; CONF-691220.

The three principal types of spectrometers currently being used for inelastic neutron scattering studies are briefly discussed. These are the triple-axis crystal spectrometer, the conventional chopper/time-of-flight spectrometer, and the correlation chopper spectrometer. In order to evaluate these devices, it is necessary to consider (a) what kind of experiments are to be performed, (b) what kind of neutron source is available, and (c) what are the advantages and disadvantages of each spectrometer in relation to items (a) and (b). Two categories of experiment are defined, according to whether it is desired to study only limited regions of the scattering function (type (A)) or whether essentially the whole function is of interest (type (B)). Neutron sources are classified as being either continuous, as from a steady-state reactor, or pulsed, by which we mean that neutron pulses of 5 μs duration (say) are produced with a repetition rate between 50 and 1000 pulses/s. It is concluded that if a steady-state source is available, there are very few experiments, either of type (A) or (B), for which the conventional chopper offers any significant advantages over the triple-axis crystal spectrometer, or over the correlation chopper, if the full development of its potential is realized. Almost all type (A) experiments are best performed with the triple-axis spectrometer. If a pulsed source is available, on the other hand, the conventional chopper is favoured for type (B) experiments, and, with provision of adequate on-line data-handling facilities, it would compete successfully with the triple-axis crystal spectrometer for many type (A) experiments also. A description is given of four experiments which have been performed both with triple-axis crystal spectrometers and conventional chopper/time-of-flight spectrometers, in order to illustrate the relative merits of these devices. (22 references) (auth)

15923 COMPARISON OF DIFFERENT INSTRUMENTS WITH RESPECT TO MEASUREMENTS ON LIQUIDS. Dorner, B.; Stiller, H. H. (Kernforschungsanlage, Juelich, Ger.). pp 19-35 of Instrumentation for Neutron Inelastic Scattering Research. Vienna; International Atomic Energy Agency (1970).

From Meeting on Instrumentation for Neutron Inelastic Scattering Research, Vienna, Austria. See STI/PUB-275; CONF-691220.

The determination of S (κ,ω) for liquids is discussed. Incoming energies, energy transfer, intensities, resolution and the possibilities of focusing are discussed, comparing the requirements from the physical problem with the available features of different instruments. The use of more than one analysing system with a three-axis spectrometer will be worthwhile for liquids and will improve the intensity comparison to time-of-flight instruments. With a three-axis spectrometer the resolution is connected with focusing conditions. These focusing conditions are very characteristic advantages of a three-axis spectrometer. With respect to investigations of liquids this focusing plays a role, at least for Brillouin scattering. The size of the so-called resolution ellipsoids is discussed with respect to available crystals and accessible spectrometer angles. The possibilities and requirements of Brillouin scattering with neutrons are presented in detail. This method, where scattering takes place near the origin of reciprocal space without involving any "reciprocal lattice vector," is of special interest for the investigation of collective modes in liquids. The necessity that the velocity of the incoming neutrons has to be higher than the phase velocity of the phonon or quasi-phonon requires high incoming energies. From the high incoming energies it follows that the possible scattering angles are small. The intensity is not high, but several such experiments have been performed. (auth)

15924 COMPARISON OF NEUTRON-SCATTERING TECHNIQUES WITH REGARD TO RESOLUTION AND INTENSITY. Stedman, R. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 37-47 of Instrumentation for Neutron Inelastic Scattering Research. Vienna; International Atomic Energy Agency (1970).

From Meeting on Instrumentation for Neutron Inelastic Scattering Research, Vienna, Austria. See STI/PUB-275; CONF-691220.

Monochromators and analysers are considered with respect to the intensity distribution of neutron momenta. The distribution for a crystal is used as a model, and distributions for single "channels" of other instruments treated by analogy. Various types of experiment and appropriate spectrometers are discussed. It is concluded that for examining the fine structure of phonon and magnon dispersion curves, molecular spectrometry, and small-angle scattering the crystal spectrometer is a good instrument, while for liquids TOF analysers are probably preferable. (auth)

15925 RESOLUTION OF NEUTRON SPECTROMETERS FOR INELASTIC NEUTRON SCATTERING. Bjerrum Moeller, H.; Nielsen, M. (Atomic Energy Commission Research Establishment, Risoe, Denmark). pp 49-76 of Instrumentation for Neutron Inelastic Scattering Research. Vienna; International Atomic Energy Agency (1970).

From Meeting on Instrumentation for Neutron Inelastic Scattering Research, Vienna, Austria. See STI/PUB-275; CONF-691220.

A number of papers on the experimental resolution of neutron spectrometers for inelastic neutron scattering have been published in recent years. Various methods have been used to obtain the instrumental width of a measured neutron group: (i) calculation of an analytical expression for the resolution function and the use of this for computation of the instrumental width of a neutron group; (ii) calculation of the individual contributions to the instrumental width, resulting from finite collimations, mosaic spread, finite pulse time etc., the sum of these contributions giving the total instrumental width of a measured neutron group; (iii) the use of graphical methods for studying focusing effects; (iv) measurement of the resolution function for elastic settings of the spectrometer (Bragg reflection); and (v) calculation of the resolution by a Monte-Carlo simulation. A review and a

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comparison of these different methods for triple-axis spectrometers and time-of-flight spectrometers are given. (auth)

15926 EFFICIENCY OF NEUTRON CRYSTAL SPECTROMETERS IN THE WAVELENGTH RANGE 4 TO 10 A. Bally, D. (Inst. for Atomic Physics, Bucharest). pp 77-90 of Instrumentation for Neutron Inelastic Scattering Research. Vienna; International Atomic Energy Agency (1970).

From Meeting on Instrumentation for Neutron Inelastic Scattering Research, Vienna, Austria. See STI/PUB-275; CONF-691220.

The optical parameters which determine the resolution and the luminosity of a crystal monochromator are analyzed. The relative reflectivity is calculated for two crystal arrangements: the symmetrical reflection arrangement and the symmetrical transmission arrangement. For these two arrangements the most favourable values of the ratio between the mosaic spread and collimator divergences and of the "monochromator efficiency" are also calculated. The optical parameters of a double-crystal monochromator are analysed. A criterion to estimate the efficiency of such a monochromator is obtained. Also, an experimental set-up for very cold neutron-scattering experiments is analyzed. Concrete calculations are made assuming that the set-up will be used with a high-flux pulsed reactor. Luminosities for the same resolution of different right optical-tube systems, in connection with a beryllium filter and/or a chopper phased with the reactor, are compared. It is shown that for a mean thermal neutron flux of 10^{14} n/cm^2 s, by using a cold moderator, a simple and flexible experimental set-up can be used up to 10 Å. It is also shown that in this device it is convenient to use a double-crystal monochromator up to 6 Å. From 6 Å to 15 Å, a beryllium filter must be used. For longer wavelengths an appropriate arrangement of the optical tubes must be chosen. (auth)

15927 THEORY AND OPTIMIZATION OF CORRELATION TIME-OF-FLIGHT EXPERIMENTS. Hossfeld, F. (Kernforschungsanlage, Juelich, Ger.); Amadori, R.; Scherm, R. pp 117-45 of Instrumentation for Neutron Inelastic Scattering Research. Vienna; International Atomic Energy Agency (1970).

From Meeting on Instrumentation for Neutron Inelastic Scattering Research, Vienna, Austria. See STI/PUB-275; CONF-691220.

The principles of the correlation method are presented on the basis of a generalized theory taking account of (pseudo)-statistical sequences of arbitrary duty cycle. By comparison of the conventional time-of-flight experiment with the correlation method a gain factor is obtained depending on the structure of the time-of-flight spectrum, on the background level, and on the period and the duty cycle of the chopper sequence. Thus, correlation experiments can be optimized by selecting adequate sequences with an optimum duty cycle. A survey of all classes of binary pseudo-statistical sequences so far known is given, including shift-register sequences as a small class with a duty cycle c = 0.5. Briefly, the application of Markov chains as aperiodic sequences in connection with on-line correlation is discussed and some preliminary remarks are made on uncorrelated pseudo-statistical sequences with respect to the design of a statistical double chopper. Computer simulations of time-of-flight experiments demonstrate the power and limitations of the correlation method. The input-transducer error involved in real pulse shapes and its influence on the correlation experiment are analyzed. (auth)

15928 MAGNETICALLY-PULSED TIME-OF-FLIGHT SPECTROMETER FOR INELASTIC NEUTRON SCATTERING. Mook, H. A.; Wilkinson, M. K. (Oak Ridge National Lab., Tenn.). pp 173-80 of Instrumentation for Neutron Inelastic Scattering Research. Vienna; International Atomic Energy Agency (1970).

From Meeting on Instrumentation for Neutron Inelastic Scattering Research, Vienna, Austria. See STI/PUB-275; CONF-691220.

A very versatile time-of-flight spectrometer, which utilizes a magnetically-pulsed neutron beam, has been developed for inelastic neutron-scattering investigations of liquids and solids. The beam is pulsed by changing the direction of the atomic magnetic moments in a ferrite crystal with an applied magnetic field. The (111) reflection of ^{7}Li ferrite with the correct composition is almost entirely due to magnetic scattering; thus the intensity of the beam can be varied from essentially zero with the field applied along the scattering vector to a maximum when the field is applied perpendicular to the scattering vector. Good reflectivity can be obtained with these ferrite crystals, and since the magnetic anisotropy is small, the magnetic spin system can be changed rapidly by small external magnetic fields. The single crystal thus serves both as monochromator and pulser, and any type of pulse shape or length can be readily obtained because the pulsing is accomplished electronically. The pulse-repetition rate can also be varied continuously so that the magnetic pulser can operate in any type of auto-correlation mode. This magnetically-pulsed time-of-flight spectrometer is presently under construction and will be installed at the High Flux Isotope Reactor at ORNL. The ferrite crystal will be placed in a large rotatable shield for continuous variation of the neutron wavelength, and a bank of detectors giving a flight path of 1.5 metres will rotate with the monochromator shield. The instrument will be on-line to a Digital Equipment Corporation PDP 15-30 computer, which will operate the magnetic pulser in the optimum manner for a given experiment. If an auto-correlation mode is desired, the computer will pulse the crystal with the desired code of pulses, collect and cross-correlate the time-of-flight data, and display the results of the measurement. The computer will also be used to accurately position the monochromator, sample, and detectors by means of pulsed motors, making it possible to scan along symmetry directions of a single-crystal sample. Such computer operation allows tremendous flexibility of operation and makes the spectrometer useful for a wide variety of experiments. (auth)

15929 DEVELOPMENT AND IMPROVEMENTS OF SPIN-FLIP-CHOPPER SPECTROMETERS. Rauch, H. (Oesterreichische Hochschule, Vienna). pp 181-96 of Instrumentation for Neutron Inelastic Scattering Research. Vienna; International Atomic Energy Agency (1970).

From Meeting on Instrumentation for Neutron Inelastic Scattering Research, Vienna, Austria. See STI/PUB-275; CONF-691220.

A spin-flip-chopper produces behind the resonance spin-flip of a polarized neutron spectrometer a monochromatic neutron beam with a spin-direction periodically up or down. Behind the analyzer there is a chopped neutron beam. The repetition rate (up to 50 kHz) of the neutron bursts and the duty cycle (usually about 50%) can be chosen electronically to fulfil the experimental requirements much better than the usual mechanical choppers. The spin-flip-chopper is especially favorable for investigating inelastic magnetic scattering, where the sample acts as analyzer too, and for the quasi-elastic part of the spectrum. The chopping action of the resonance coil can be done either by periodically switching on and off the high-frequency field, which lies in the direction of the neutron beam or by periodically switching on and off a suitable precision field perpendicular to the beam. Under optimum conditions it is possible to produce chopped neutron beams with a higher peak intensity and a better resolution than with mechanical choppers. A good time resolution requires a short resonance coil or a space- and time-dependent amplitude of the high-frequency field. The usual time-of-flight analysis is not necessary for the new double-spin-flip-chopper device consisting of two spin-flip-choppers running at a distinct flight path and with an adjustable phase difference. This instrument can be used similarly to a neutron selector but with a much better flexibility and transmission. As a note a new neutron-source geometry is suggested which produces a strong anisotropic emission of neutrons in the direction of the first collimation of any inelastic neutron-scattering set-up. This source consists of a curved sandwich arrangement of moderating material and open channels, which are partly Ni-coated by vacuum deposition to obtain total reflection in the desired direction. (auth)

15930 SOME PROBLEMS OF NEUTRON SPECTROSCOPY AT PULSED SOURCES. Kroo, N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 211-23 of Instrumentation for Neutron Inelastic Scattering Research. Vienna; International Atomic Energy Agency (1970).

From Meeting on Instrumentation for Neutron Inelastic Scattering Research, Vienna, Austria. See STI/PUB-275; CONF-691220.

Due to the relatively long pulses available from a pulsed reactor, especially for cold neutrons, further tailoring of the neutron beams is required in order to get a reasonable resolution for inelastic slow neutron-scattering studies. The simplest solution to this problem can be achieved by using mechanical choppers phased with the reactor to shorten the neutron pulses. This method leads to big losses in neutron intensity. One possible way to reduce these losses might be the combination of the correlation and classical pulsed time-of-flight methods. The advantages of a spectrometer working on the basis of this combined principle are shown and a possible way of realization is described. (auth)

15931 HIGH ENERGY GAMMA RAY SOURCE. Litherland, Albert E.; Alexander, Thomas K.; Jeffs, Alan T. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,520,819. 21 Jul 1970. Filed 7 Sep 1967.

A gamma ray source is described in which the capture of energetic alpha particles by certain element nuclei result in an excited state of a daughter element of higher atomic number and which has a sufficiently long life time in that state before decay by gamma radiation, so that the recoil velocity consequent upon the alpha particle absorption makes negligible contribution to broadening of the gamma ray spectrum line. The source of alpha particles must be energetic and preferably comprises plutonium,

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curium, or americium and the element used for capture is preferably boron 10 or carbon 13. (auth)

15932 THE DETERMINATION OF THE TRANSMISSION FUNCTION OF A NEUTRON CHOPPER WITH CIRCULAR SLITS, AND ITS USE IN MEASURING COLD SOURCE SPECTRA. Ross, D. K.; Winfield, D. J. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods; 91: 159-68(1971).

Numerical calculations of the transmission function of a neutron chopper with circular slits are performed for cases in which the approximations used in the deduction of Larsson's formula become significantly large. The present calculations show a shift in the mean velocity transmitted that is rather larger than that predicted by Cocking. The other main conclusion is that the efficiency of the chopper as a monochromator can be optimized by a suitable choice of the radii of the inner and outer slit walls. An experimental curve was derived by comparing spectra at different rotor frequencies; and this showed small discrepancies from the theoretical function, which were attributed to slit-wall distortions in use. This experimental curve was also used to derive cold source spectra, a knowledge of which is essential to the design of an improved cold source. (auth)

15933 A SIMPLE COMPACT MOESSBAUER SINGLE-LINE SOURCE. Helms, W. R.; Mullen, J. G. (Purdue Univ., Lafayette, Ind.). Nucl. Instrum. Methods; 91: 291-2(1971).

A single-line, room-temperature Mössbauer source of cobaltous oxide doped with lithium is described. This source, which has θ_M = 410 K, $\Gamma = 0.22 \pm 0.02$ mm/sec, permits maximum radioactive specific activity. (auth)

15934 MOESSBAUER THROUGH-TRANSMISSION VERSUS BACKSCATTER GEOMETRY COMPARISON. Ord, R. N.; Christensen, C. L. (Battelle Memorial Inst., Richland, Wash.). Nucl. Instrum. Methods; 91: 293-4(1971).

A comparison of a Mössbauer through-transmission geometry to backscatter geometry shows the latter to have a larger percent effect and, therefore, an advantage in counting time. (auth)

15935 MAGNETIC NEUTRON SPECTROMETERS FOR NEUTRONS WITH WAVELENGTHS GREATER THAN 40 A. Golub, R. (Univ. of Sussex, Eng.); Carter, P. Nucl. Instrum. Methods; 91: 205-9(1971).

The use of a hexapole magnet as a neutron spectrometer is reexamined in the light of the increasing interest in long-wavelength neutrons and the availability of superconducting magnets. The efficiency of a hexapole-magnet spectrometer is compared with that of a time-of-flight spectrometer using a curved-slit monochromator. A proposed experiment to measure quasi-elastic scattering from liquid Na near the melting point with $|\omega| \lesssim 1.5 \times 10^{10}$ rad/sec and $Q = 10^{-1}$ Å^{-1} is taken as an example. The magnetic spectrometer offers significant intensity advantages over the time-of-flight spectrometer for this sort of experiment. (auth)

15936 COMPTON-SUPPRESSED Ge(Li) SPECTROMETER (31 Dec 1969) (Engineering Materials). (Massachusetts Inst. of Tech., Cambridge). (CAPE-2055).

3 drawings.

The spectrometer consists of a 0.5 cm^3 Ge(Li) detector with a photopeak with full-width at half-maximum (FWHM) of 0.45 keV for the 14.4 keV line of ^{57}Co and two large Ge(Li) detectors, 26 cm^3 and 19 cm^3, with FWHM values of 25 and 2.2 keV for the 1332 keV line of ^{60}Co. The 19 cm^3 Ge(Li) detector is located inside a large NaI(Tl) annulus which acts as a Compton suppressor. Events in which Compton-scattered γ rays from the Ge(Li) detector are absorbed in the annulus and removed from the spectrum by anticoincidence pulses into an analog-to-digital converter are described. The entire assembly including the annulus is placed in a Pb cave to eliminate background. A Pb collimator between the source and the 19 cm^3 detector shields the annulus from direct radiation from the source. The Compton suppressor increases the peak height/Compton-shoulder-height ratio from 20 with the detector alone to ≈140 with the annulus in place for 662 keV γ rays of ^{137}Cs. (For details see TID-4100 Suppl. 62) (F.S.)

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Refer also to abstracts 17639, 17640, and 17641.

15937 (NAL-tr-3) HIGH-RESOLUTION DIFFERENTIAL CHERENKOV COUNTERS. Gorin, Yu. P.; Denisov, S. P.; Donskov, S. V.; Krasnokutskii, R. N.; Petrukhin, A. I.; Prokoshkin, Yu. D.; Stoyanova, D. A.; Shuvalov, R. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov, Institut Fiziki Vysokikh Energii). Translated for National Accelerator Lab., Batavia, Ill., from Russian report IHEP-70-48. 14p. Dep. NTIS.

Differential Cherenkov gas counters detecting Cherenkov light at angles θ = 12 and 23 mrad are described. The counter lengths are 5 m (θ = 23 mrad) and 10 m (θ = 12 mrad). The spectral band is 250 to 600 nm (2500 to 6000 Å), and the counting gas is helium. The counter characteristics were investigated in particle beams of the 70-GeV IHFE with momenta of 35, 40, and 45 GeV/c. The velocity resolution was measured as 2×10^{-6} for the 10-m counter and 6×10^{-6} for the 5-m counter. The 10-m counter can be utilized to separate pions and kaons with momenta of up to ~200 GeV/c, and kaons and protons (anti-protons) with momenta of up to ~350 GeV/c. (auth)

15938 MEASUREMENTS ON A SEPARATED FUNCTION SHOWER DETECTOR WITH A PHOTON BEAM OF KNOWN AND VARIABLE ENERGY. McFarlane, W. K. (Temple Univ., Philadelphia); Rothe, K. W.; Wadlinger, E. A. Nucl. Instrum. Methods; 91: 85-91(1971).

Measurements on the behavior of a separated function Cherenkov shower detector for the detection of gamma rays and electrons in the 300 to 1600 MeV range are reported. Detection efficiencies have been examined at the 1% level. Pulse height spectra are also presented. (auth)

15939 RUTHERFORD LABORATORY HIGH FIELD BUBBLE CHAMBER. Butterworth, I. (Rutherford High Energy Lab., Chilton, Eng.). pp 547-55 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

The design of a high-field bubble chamber is described. This chamber is designed to expand 10 times per second. An improvement over present chambers is noted for resolution and data acquisition rate. (J.F.P.)

15940 PROP-SPARK HYBRID CHAMBER. Fischer, J.; Shibata, S. (Brookhaven National Lab., Upton, N. Y.). pp 641-4 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

A combination of a wire proportional detector with a very narrow gap pulsed spark chamber which combines the advantages of the short time resolution of the multiwire proportional detector with the event-selecting ability and the inexpensive readout of the spark chamber is described. (W.H.K.)

15941 5000 WIRE PROPORTIONAL CHAMBER READOUT SYSTEM FOR A LARGE-APERTURE MAGNET SPECTROMETER. Cunitz, H. (Columbia Univ., New York); Sippach, W.; Dieperink, J. Nucl. Instrum. Methods; 91: 211-20(1971).

Design of a large proportional wire-chamber readout system that achieves short resolving time with high detection efficiency for 2 mm wire spacing is described. Low-deadtime decision logic rejects uninteresting events. (auth)

15942 CONSTRUCTION AND PERFORMANCE OF LARGE MULTIWIRE PROPORTIONAL CHAMBERS. Schilly, P. (CERN, Geneva); Steffen, P.; Steinberger, J.; (and others). Nucl. Instrum. Methods; 91: 221-30(1971).

Large-area multiwire proportional chambers were developed; in particular, a chamber 2 m × 0.5 m, using both horizontal and vertical wires (≈1500 wires in all), was constructed. The chamber performance is very nearly the same as that of smaller chambers. Detailed design and performance data are presented. (auth)

15943 EXPERIMENTAL TEST OF THE STREAMER BREAKDOWN CRITERION. Cavenor, M. C. (Univ. of New England, Armidale, Australia). Aust. J. Phys.; 23: 953-6(Dec 1970).

At large overvoltages, single avalanches (streamers) bridge an electrode gap within the transit time of the initial avalanche of a filamentary spark channel. The charge carrier number in the initial avalanche should reach 10^9, so for initiation by a single photoelectron, the amplification of the avalanche, exp αd, should be 10^9 thus αd must be of the order of 20 ion pairs. For the case of hydrogen, the percentage overvoltage required to establish this condition was calculated for given pd values. (Australia)

15944 BALLOON-BORNE GAS CHERENKOV-SCINTILLATOR TELESCOPE FOR THE MEASUREMENT OF THE CHARGE SPECTRUM OF COSMIC-RAY NUCLEI AT HIGH ENERGIES. Von Rosenvinge, Tycho Tor. Minneapolis; Univ. of Minnesota (1970). 125p. University Microfilms Order No. 70-20,243.

Thesis.

A system for measuring the charge spectrum of cosmic ray

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nuclei at energies between 1.5 and 21 eV/nucleon has been designed and flown in two balloon flights. The system consists of a gas Cherenkov detector sandwiched between two large scintillator counters. The gas Cherenkov detector provided an energy threshold of approximately 14 GeV/nucleon for the first flight and of 21 GeV/nucleon for the second. (TSS) (Diss. Abstr. Int., B)

Radiation Dosimeters

Refer also to abstracts 15849, 15882, 15961, and 18191.

15945 (AD-711588) INTRINSIC EFFICIENCY OF THERMOLUMINESCENT DOSIMETRY PHOSPHORS. Final Report. Lucke, William H. (Naval Research Lab., Washington, D. C.). 13 Aug 1970. Contract AT(49-7)-1864. 43p. (NRL-7104). NTIS.

The intrinsic efficiency is defined as the ratio of light energy emitted during heating to energy absorbed during gamma irradiation. This factor was measured for four commonly used thermoluminescent phosphors to give the following results: LiF (TLD-100), 0.039%; Li2B407:Mn, 0.073% (both corrected for supralinearity); CaF2:Mn, 0.44%; and CaS04:Mn, 1.2%. The method of measurement involved calibrating a detector, which consisted of a narrow bandpass filter in conjunction with a photomultiplier, by means of the light of a standard lamp diffusely reflected from a MgO button having the same size, shape, and position as the phosphor-bearing planchet. A correction was made to account for the fact that the phosphor samples were not Lambertaian sources. (auth) (USGRDR)

15946 (ANL-7760(Pt.1), pp 13-20) RADIOPHOTOLUMINESCENT DOSIMETRY EMPLOYING A UV LASER. Kastner, Jacob; Strash, A. M.; Langs, R. K.; Lutz, W. J.; Dunlop, J. T. (Argonne National Lab., Ill.).

From Radiological Physics Division annual report.

A spectrophotometric study of the photoluminescence of silver phosphate glasses has been carried out to establish the excitation wavelength which will provide the optimum ratio of postdose to predose fluorescence. A Cd-He laser (3250 Å) was employed with a Kerr cell to determine the decay of the radiophotoluminescence of Toshiba dosimetric glasses. Two components were observed with decay constants of 2.6 and 28 μsec. The system is very efficient and should provide an ultrasensitive dosimetric technique. (auth)

15947 (ANL-7760(Pt.1), pp 21-7) RELATIONSHIP BETWEEN ENCAPSULATION AND APPARENT FAST NEUTRON-INDUCED FADING IN THERMOLUMINESCENT DOSIMETERS. Wallace, R. H.; Ziemer, P. L.; Kastner, Jacob; Oltman, B. G. (Argonne National Lab., Ill.).

From Radiological Physics Division annual report.

It is established that the apparent fast neutron-induced fading in thermoluminescent ^{7}LiF reported earlier is actually an artifact which results from the encapsulation in polyethylene. This does not occur with glass encapsulation. (auth)

15948 (CEA-N-1393) POCKET DOSIMETERS MEASURING THE ABSORBED DOSE IN SOFT TISSUES OF 300 mg.cm^{-2} THICKNESS, FOR PHOTONS OF ENERGY >10 keV AND FOR ELECTRONS. Sklavenitis, Laodamas; Pages, Lucien (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1970. 14p. (In French). Dep. NTIS (U.S. Sales Only).

The application of the ICRP recommendations requires knowledge about the absorbed dose in tissues of a given thickness. The energy response of the various detectors and particularly the pocket dosimeters, widely used as personal dosimeters, depends upon their construction. Many of them are either too sensitive or insufficiently sensitive, particularly in the 10 to 100 keV energy range. The study of several prototypes with walls made of different materials, led to the development of a pocket dosimeter having an energy response proportional to that of soft tissues of 300 mg.cm^{-2} thickness, for photons of energy greater than 10 keV and for electrons. (auth) (France)

15949 (CLOR-80/D) PERSONNEL FILM MONITORING OF FAST NEUTRONS IN CENTRAL LABORATORY FOR RADIOLOGICAL PROTECTION. Jasiak, J.; Musialowicz, T. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1970. 15p. (In Polish). Dep. NTIS (U. S. Sales Only).

In the Central Laboratory for Radiological Protection a personnel fast neutron monitoring service is carried out, using Kodak PNM Films Type A. The films are calibrated with a Po-Be source and developed in Kodak Developer D-19b. The counting of recoil proton tracks is made by using a projector microscope type MP-3/PZO Warszawa/. The total magnification on the screen is 2500. The average number $1.6 \cdot 10^4$ tracks per square centimeter corresponding to 1 rem was found (assuming that $2.67 \cdot 10^7$ n/cm^2 correspond to a dose equivalent of 1 rem). (auth)

15950 (CLOR/IBJ-78) ESTIMATION OF OPTICAL DENSITY EQUIVALENT DOSES FOR THERMAL NEUTRONS AND GAMMA RADIATION. Musialowicz, T.; Wysopolski, J.; Kucharski, M.; Filipiak, B.; Bogdanowicz, St.; Zasempa, W. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1970. 13p. (In Polish). Dep. NTIS (U. S. Sales Only).

In the report the correction coefficients for estimation of the thermal neutron dose equivalent in the presence of gamma radiation for the new type of film badge with 0.3 mmPb + 0.5 mmCd converter, 0.3 mmPb + 0.6 mmSn filter and film type UP FOTON are given. The experimentally found coefficients for estimation of the components of the whole dose on the basis of the calibration curve of radium are given. (auth)

15951 (RFP-794) POCKET-SIZE INTEGRATING NEUTRON COUNTER. Johnson, Valens P., Tyree, William H.; Falk, Roger B. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 22 Jan 1971. Contract AT(29-1)-1106. 7p. Dep. NTIS.

A compact integrating neutron-flux counter using a solid-state detector and mercury microcoulometer is described. The counter provides a visual indication of the number of pulses detected. A description of the field use and the limitations of the counter for personnel neutron-dose estimation are included. (auth)

15952 (RFP-1581) PERSONNEL NEUTRON DOSIMETER USING LITHIUM FLUORIDE THERMOLUMINESCENT DOSIMETERS. Falk, Roger B. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 20 Jan 1971. Contract AT(29-1)-1106. 18p. Dep. NTIS.

A neutron dosimetry system using commercial lithium-fluoride ribbon thermoluminescent dosimeters has been developed. The system is designed to cover the range of neutron spectra found in plutonium glove-box operations. The physical size is approximately the same as a conventional neutron film packet (1⅝ by 1^5/$_{32}$ by ⅛ inches). The minimum dose measurable is 10 to 20 millirem in the presence of 100 millirem photon dose. The dose response is essentially independent up to 10 centimeters of moderator thickness. (auth)

15953 A STUDY OF THERMALLY STIMULATED ELECTRON EMISSION FROM LITHIUM FLUORIDE. Kopp, David Theodore. Lawrence, Kan.; Univ. of Kansas (1970). 82p. University Microfilms Order No. 70-25,364.

Thesis.

The effects of thermal annealing and of environmental gases on the TSEE response of LiF exposed to x-radiation were studied. Thermal annealing in air at 100°C and at 200°C for up to 48 hours increased the response of LiF by only 25%. After 24 hours at 300°C the TSEE response had decreased to an equilibrium level 40% below that of unannealed LiF. After 48 hours of annealing in air at 400°C the TSEE response is 2.6-times that of unannealed LiF. Annealing in vacuum at 300°C increases the TSEE response by 20% over that of LiF annealed in air at 300°C. Annealing in vacuum at 400°C for 12 hours results in a TSEE response 5.5-times that of unannealed LiF and 2.5-times that of LiF annealed in air at 400°C for 12 hours. After annealing in vacuum at 500°C for greater than 12 hours the TSEE response is 6-times that of unannealed LiF. Storage of an annealed LiF-graphite mixture in air or in oxygen prior to exposure to 100 KVP x-rays increases the TSEE response. A mixture of 50% LiF and 50% graphite annealed in air for 12 hours at 300°C increases in response by 50% after 16 days storage in air and by 33% after 16 days storage in oxygen. A mixture of 50% LiF and 50% graphite annealed in vacuum for 24 hours at 400°C increases in response by 50% after 16 days storage in air and by 82% after 16 days storage in oxygen. The response of LiF-graphite mixtures stored in closed plastic vials remains constant over the same period of time. (TSS) (Diss. Abstr. Int., B)

15954 DOSIMETRY IN THE RADIATION FIELD OF A 15 MeV NEUTRON SOURCE WITH THE AID OF THERMOLUMINESCENCE OF LiF. Steinbach, Karl Heinz (Heiligenberg-Institut, Ger.). Atomkernenergie; 16: 261-2(1970). (In German).

The use of ^{7}LiF thermoluminescent dosimeters in a mixed n + γ field of a 15 MeV neutron source is described. By the knowledge of the different detector sensitivities it is possible to separate the dose contributions of the two kinds of radiations. The γ-component of the radiation field was estimated to be (5 ± 2)% of the neutron absorbed dose. (auth)

15955 PREPARATION OF THERMOLUMINESCENT LITHIUM FLUORIDE. Rossiter, M. J.; Rees-Evans, D. B.; Ellis, S. C.

(National Physical Lab., Teddington, Eng.). J. Phys., D (London); 3: 1816-23(Dec 1970).

The preparation of lithium fluoride with thermoluminescence properties suitable for use in radiation dosimetry was investigated. Variants based on magnesium and titanium additions were prepared and examined from the viewpoint of activator concentration, role of secondary impurity, and purity of the lithium fluoride starting material. The following properties were examined: impurity distribution and luminescence distribution within the crystal, emission spectrum, dose response characteristics, and optical absorption. A sensitive thermoluminescent preparation may be obtained by the addition of magnesium alone to a readily available source of lithium fluoride. (auth) (UK)

15956 THERMOLUMINESCENCE PROPERTIES OF DYSPROSIUM- AND THULIUM-ACTIVATED CALCIUM SULFATE PHOSPHORS AT HIGH GAMMA DOSES. Nambi, K. S. V.; Higashimura, Takenobu (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 595-7(Nov 1970).

TL glow curves after nigh gamma irradiation (~10^6R), gamma sensitivity, and ultraviolet sensitivity for $CaSO_4$:Tm thermoluminescent dosimeters are discussed. (W.H.K.)

Radiometric Instruments

Refer also to abstract 15769.

15957 (AEC-tr-7197) BELT-CONVEYOR WEIGHING EQUIPMENT WITH RADIOISOTOPIC SCATTERING PROBES. PART I. CONSTRUCTION OF THE WIT-2 WEIGHER. Scharf, Waldemar. Translated by A. Skup from Pomiary, Automat., Kontr.; 14: 441-4(1968). 19p. Dep. NTIS.

An abstract of this paper, prepared from the original language appeared as NSA 24: 507.

15958 (ORO-3842-2) RADIOISOTOPE X- AND GAMMA-RAY METHODS FOR FIELD ANALYSIS OF WET CONCRETE QUALITY. PHASE II. INSTRUMENT DESIGN AND OPERATION. Final Report. Berry, P. F. (Nuclear-Chicago Corp., Austin, Tex. Texas Nuclear Div.). 30 Sep 1970. Contract AT(40-1)-3842. 98p. Dep. NTIS

The design and operation of a prototype instrument for the field determination of cement in wet (plastic) portland cement concrete are described. Gamma-ray scattering techniques are used in a probe of submersible design. Two radioisotope sources, ^{241}Am and ^{137}Cs, are employed with a single scintillation counter detector. The electronic unit simultaneously registers the two intensities and the cement content is interpreted from a calibration curve. The measurement is compensated for bulk density and water content variation and is insensitive to aggregate particle size. Compensation for aggregate type is discussed. The instrument is portable, rugged and simple to operate. The method appears sound for concrete mixes containing aggregates which are predominantly silicious in nature. Although applicable to aggregate mixes which contain some limestone, accuracy declines rapidly with increasing limestone content as a result of the reduction in the intrinsic sensitivity to cement factor and the increase in the bulk density influence. (auth)

15959 USE OF SYMMETRICAL PROBE INSTALLATIONS IN RADIOACTIVE WELL LOGGING DEVICES. Pestrikov, A. S. Razved. Geofiz.; No. 37, 108-11(1970). (In Russian).

A radiation logging device with γ-radiation detectors distributed symmetrically to the neutron source and connected to one channel is described. (R.V.J.)

15960 EXPERIENCES WITH AN ISOTOPE THICKNESS GAUGE IN AN AUTOMATED PLATE AND SHEET ROLLING MILL. Wiethoff, Gert; Knorr, Frierrich; Sass, Dieter; Fleischer, Reinhard. Stahl Eisen; 89: 1294-1300(13 Nov 1969). (In German).

The operation of an isotope thickness gauge in an automated plate and sheet rolling mill is described. The instrument is based on the absorption of γ-radiation from a ^{137}Cs source. The method of measurement and the automatic application of corrections are described. (Metals Abstr.)

Miscellaneous Instruments and Components

Refer also to abstracts 15884, 16393, 16564, 16617, 17623, 18130, and 18187.

15961 (ANL-7760(Pt.1), pp 1-12) EFFICIENT KERR CELL FOR USE IN THE UV. Strash, A. M.; Langs, R. K.; Kastner, Jacob (Argonne National Lab., Ill.).

From Radiological Physics Division annual report.

An ultraviolet Kerr cell shutter is described which has several advantages over available solid state Pockels cells. Several liquids with reasonably good Kerr constants permit the use of this shutter at wavelengths below 3000 Å. New fluoride compounds possess advantages over previously described liquids for use in the Kerr cell. (auth)

15962 (CEA-R-4022) ELECTRON PARAMAGNETIC RESONANCE SPECTROMETERS OPERATING UNDER IRRADIATION. Santier, Christian (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Dec 1970. 149p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Grenoble, France.

Two laboratory constructed paramagnetic resonance spectrometers for in-situ studies of radiation induced defects are described. One of these instruments is associated with the core of a nuclear reactor, operating in a mixed flux of neutrons and gamma rays. The other is used in conjunction with a gamma radiation source. Some experimental results obtained with these instruments are discussed. (auth) (France)

15963 (NBS-TN-556) DEVELOPMENT AND CURRENT STATUS OF THE STANDARD NUCLEAR INSTRUMENT MODULE (NIM) SYSTEM. Costrell, Louis (National Bureau of Standards, Washington, D. C.). Oct 1970. 15p. GPO $0.30.

The need for a standard module system, history of development, advantages, general description, NIM instruments, and dataway operations are discussed. (W.H.K.)

15964 (NP-18602) ANNUAL REPORT, 1969. (Kernforschungsanlage, Juelich (West Germany)). 256p. (In German). Dep. NTIS (U. S. Sales Only).

The development and goals of the Juelich Nuclear Research Center in 1969 are reported. The general development of the research installation is outlined and the large projects, especially on the study of high temperature reactors, are briefly reported. The scientific and engineering devices and instrumentation developed are described. The scientific publications, internal reports, and contributions to meetings and conferences are tabulated. Work done in botany and microbiology, zoology and radioagronomy, medicine, physical chemistry, nuclear physics, solid-state and neutron physics, instruments and electronics, engineering physics, reactor construction elements, reactor materials (including hot cells), reactor development, and plasma physics is briefly summarized. (J.S.R.)

15965 (UJV-2490-R-A) DILATOMETER FOR IRRADIATION EXPERIMENT WITH TUBE FUEL ELEMENT. Krejci, M.; Pilat, M.; Sipek, B. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Nov 1970. 36p. (In Czech). Dep. NTIS (U. S. Sales Only).

A dilatometer for measuring permanent deformations of fuel elements during the irradiation in a gas loop of the VVRS reactor is described. A measurement device with an aluminium wound induction transmitter has been designed and constructed, which can be used inside the irradiation loop channel above the active zone of a reactor in a thermal neutron flux of abt. 3×10^{10} n cm^{-2} s^{-1}. Within the range of 15 mm the transmitter nonlinearity is less than 1%. With bridge connection of the measuring and reference transmitter an accuracy of ±0.05 mm and sensitivity of more than 0.01 mm can be achieved. The temperature correction was determined up to 180°C. (auth)

15966 (WHAN-SA-23) IN-CORE, SELF-POWERED FAST NEUTRON FLUX MONITORS. Upton, J. W. Jr.; Brown, D. P.; Spear, W. G. (WADCO Corp., Richland, Wash.). 6 Nov 1970. Contract AT(45-1)-2170. 9p. (CONF-700904-5). Dep. NTIS.

From Conference on Power Reactor Systems and Components, Williamsburg, Va.

The development of self-powered fast-neutron detectors for use in reactor cores is discussed. The detector is in the form of a coaxial cable with a Be core, a MgO dielectric, and a stainless-steel outer conductor. ^6He is produced by the $^9Be(n,\alpha)$ reaction; the β decay of ^6He provides a flow of charge which can then be monitored by electronic instrumentation outside the reactor. A rod $\frac{1}{8}$ in. in diameter has a sensitivity of about 10^{-22} amp/nv; hence, for a flux level of 10^{16} nv, the sensor produces 1 μA of dc current. The ^9Be burn-up rate predicts a burn-up of only 5.41×10^{-25} %/nvt; this means a 10% drop in signal power after 60 years for the stated flux level. (R.W.R.)

XUM

15967 (WHAN-SA-24) HIGH-TEMPERATURE MEASUREMENT INSTRUMENT FOR ADVANCED REACTORS. Billeter, T. Roger; Brown, Donald P. (WADCO Corp., Richland, Wash.). 26 Oct 1970. Contract AT(45-1)-2170. 15p. (CONF-700904-2; BNWL-SA-3180-S). Dep. NTIS.

From Conference on Power Reactor Systems and Components, Williamsburg, Va.

The theory and initial experiments for an accurate, rugged, and long-lived temperature sensor, primarily intended for application in severe environments are described. For in-core application in either high-temperature, gas-cooled or liquid-metal-cooled reactors, sensor detection sensitivity remains nearly linear up to 1400°C for a niobium–1% zirconium device. For abrupt temperature changes the experimental sensor yields time constants of 0.5 to 100 seconds, depending upon the thermal conductivity of the surrounding medium. Mechanical requirements as imposed by each specific reactor application also influence the attainable time response for abrupt temperature change. Of all-metal construction, the described experimental temperature sensor with its attached waveguide should permit direct immersion in the reactor coolant and should give long-lived service. (R.W.R.)

15968 (WHAN-SA-69) INSULATION RESISTIVITY MEASUREMENTS AT HIGH TEMPERATURES. Schemmel, R. R.; Gordon, R. L. (WADCO Corp., Richland, Wash.); Bates, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 7 Oct 1970. Contracts AT(45-1)-2170; AT(45-1)-1830. 17p. (CONF-701102-16). Dep. NTIS.

From Meeting of the American Nuclear Society, Washington, D. C.

Experimental difficulties which have been overlooked while employing the four-probe technique at high temperatures to measure insulation resistance are considered. At elevated temperatures, the sample can be surrounded by a space charge resulting from thermionic emission. This space charge, composed of electrons and/or gas ions, will (in general) be a better conductor than the sample and will provide a shunt path for current around the sample. Any voltage gradient maintained in this region will result in net emission currents and atmospheric polarization which are independent of the sample resistance. These net currents will pass through the external circuit and give an erroneous indication of sample current. The actual emission currents present were measured by shorting the current probes and biasing them relative to the heater. Currents of approximately one ampere at 2000°C were detected both with and without the sample present. Emission current versus bias voltage curves showed current saturation common to thermionic emission. Use of the equivalent circuit of the system enables calculation of the current flowing between the current probes. These current values then enabled calculation of the apparent sample conductivity. Similar curves were obtained with and without the sample (ThO_2) present: this indicates that shunt paths through the atmosphere "short out" any sample current. These results support the supposition that published data on the electrical resistivity of insulation at high temperatures may be in error due to emission currents. (R.W.R.)

15969 PULSE HEIGHT TUNNEL DIODE DISCRIMINATOR. Olejniczak, Wielislaw; Zabierowski, Janusz (Univ., Lodz, Poland). Nukleonika; 15: 279-84(1970). (In Polish).

An integral pulse-height discriminator built on the Ge-tunnel diode is described. The discrimination threshold is continuously adjustable within two ranges: 0.4 to 1.4 V and 1.55 to 8.0 V. The reasons for the thermal threshold instability are mentioned. Some means of compensation are also presented. (auth)

15970 PRINCIPLES OF STRUCTURE ANALYSIS AT HIGH RESOLUTION USING CONVENTIONAL ELECTRON MICROSCOPES AND COMPUTERS. Hoppe, W. (Max-Planck Institut fuer Eiweiss- und Lederforschung, Munich. Technische Hochschule, Munich). Ber. Bunsenges. Phys. Chem.; 74: 1090-1100 (Nov 1970).

Electron microscopy, using microscopes with conventional magnetic lenses, is restructed in resolution by spherical aberration. The "zonal correction principle" allows one to surpass this limit. Its use in image reconstruction schemes allows one to separate the influence of defocusing, astigmatism etc. from the physical significant structure. The use of three-dimensional methods and of image difference methods will be necessary in order to get interpretable results in the study of the not "infinitely thin" objects in electron microscopy at the atomic level. The use of redundancy principles (such as in x-ray structure determination) is discussed and demonstrated. The most severe difficulty — especially in electron microscopy of organic specimens — is radiation damage. (auth)

15971 BEAM AND SPECIMEN: RADIATION DAMAGE AND IMAGE RESOLUTION. Cosslett, V. E. (Cambridge Univ., Eng.). Ber. Bunsenges. Phys. Chem.; 74: 1171-5(Nov 1970).

Energy loss of the electron beam in the specimen affects the electron microscopical resolution, owing to chromatic aberration, and causes radiation damage by ionization, heating, and direct ejection of atoms. Measurement recently made of the energy loss in carbonaceous specimens confirm that the effect on image resolution will be negligible in very high resolution microscopy. Additional assumptions are required in order to obtain the rate of ionization and bond breakage. On the best evidence available, it is estimated that the order of 2 chemical events will be caused during the minimum exposure needed to image an atom. The rate of ejection of atoms from carbonaceous material can be calculated rather more accurately. About 1 atom in 2500–3000 would be ejected in such an exposure, which would probably not seriously degrade a macromolecule. (auth)

15972 RADIATION DAMAGE TO AN OBJECT AS A LIMIT FOR HIGH-RESOLUTION ELECTRON MICROSCOPY. Scherzer, O. (Technische Hochschule, Darmstadt, Ger.). Ber. Bunsenges. Phys. Chem.; 74: 1154-67(Nov 1970). (In German).

A lower limit of the radiation damage in organic molecules is calculated for the case that single atoms shall be imaged. This limit is due to the breaking of chemical bonds by the recoil of nuclei in the process of deflecting the imaging electrons elastically. In thin specimens, this lower limit depends strongly on the resolution limit of the instrument, and on the atomic numbers of the atoms to be imaged and of the atom which suffers the recoil. Whether electrons or protons are used as imaging particles and what acceleration voltage is used, is of little influence. There is also not much difference in object damage between dark field, bright field, and reduced bright field. In the scanning microscope the radiation damage is much higher. The necessary resolution can be reached either by spherical correction of the objective lens or by increasing the acceleration voltage to several million volts or by using protons as imaging particles. The spherical correction can be achieved by additional unround lenses or by zone plates or, after the image has been photographed, by reprocessing the image in a computer or in an analogue-optical set. If carbon atoms shall be imaged in specimens which are sensitive to radiation and thicker than about a hundred atomic layers, there are only two promising methods: bright-field microscopy by means of spherically and chromatically corrected lenses, and image reconstruction. (auth)

15973 INTRODUCTION TO A DISCUSSION ON SPECTROMETERS AND DETECTORS. Heroux, L. (CNRS, Verrieres-le-Buisson, France). Nucl. Instrum. Methods; 90: 173-80(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

There are various photoelectric detectors that can be used as photon counters in beam-foil spectroscopy over the wavelength range 50 to 1700 Å. In general, several different detectors must be used to obtain a high and reproducible quantum efficiency with low background over this spectral range. Three groups of detectors are discussed briefly. One group for use between about 1700 and 1100 Å includes sealed detectors having alkali-halide photocathodes and lithium-fluoride windows. The second group for use between 1200 and 100 Å includes windowless detectors having high-work-function photocathodes. The third group includes gas-flow Geiger Mueller counters with thin windows for use at wavelengths shorter than 200 Å. Emphasis is placed on the operation of these detectors as photon counters having a well-defined counting plateau. (auth)

15974 OPTICAL DESIGN FOR BEAM–FOIL EXPERIMENTS. Bakken, G. S.; Jordan, J. A. Jr. (Rice Univ., Houston, Tex.). Nucl. Instrum. Methods; 90: 181-5(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

The threshold signal-to-noise ratio for several optical designs appropriate to beam-foil spectroscopy is considered. Calculation of signal-to-noise ratios is complicated by the strong Doppler effect associated with the high unidirectional velocity of the emitting ions. The Doppler effect introduces an unusual coupling of spectral resolution and signal strength, which requires modifications to the accepted methods for optimizing these parameters for weak sources. The discussion includes results on the side-on, end-on, and axicon systems, as well as modifications to the side-on system using anamorphic elements or auxiliary mirrors. (auth)

15975 COMPUTER-CONTROLLED BEAM–FOIL SPECTROSCOPY SYSTEM WITH AN APPLICATION TO ARGON. Bridwell, L.; Beyer, L. M.; Maddox, W. E.; Etherton, R. C. (Murray State Univ., Ky.). Nucl. Instrum. Methods; 90: 187-96(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

A computer-controlled system for the acquisition of beam–foil data is described. The system consists of a McPherson model 225 vuv monochromator equipped with a stepping motor on the grating drive, and connected to an IBM 1130 computer. An identical motor is used to step the foil position in lifetime measurements. System capabilities are discussed. Preliminary data on argon acquired with the system are presented. (auth)

15976 SIMULTANEOUS TEMPORAL AND SPECTRAL RESOLVANCE WITH THE FOIL-EXCITED BEAM SOURCE AND A SCANNING MONOCHROMATOR. Kay, L.; Lightfoot, B. (Univ. of Kent, Eng.). Nucl. Instrum. Methods; 90: 289-94(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

The condensing system described accepts light only within a narrow spectral band and only from ions having a small range of flight times (following excitation), yet realizes the full luminosity–resolvance product of a scanning monochromator. The limit to the overall spectral resolvance attainable due to foil effects was measured for low-energy ions of H and N and a range of carbon-foil thicknesses. Calculations of the size of the limit, assumed due to Doppler effects following multiple Coulomb scattering in the foil, are in agreement with experiment. (auth)

15977 THEORY, DESIGN, AND OPERATION OF THE MISSOURI UNIVERSITY TIME-OF-FLIGHT SPECTROMETER. Gault, John Dale. Columbia, Mo.; Univ. of Missouri (1970). 167p. University Microfilms Order No. 70-20,778.

Thesis.

The theory of the Fermi chopper is examined in detail including the effect of the chopper having slits considerably off the axis of rotation. Burst shapes are analytically determined for slits off the axis of rotation and the results of a computer calculation of the transmission functions for these slits are presented. The burst shape for a slit on the axis of rotation is integrated to obtain the known expressions for the chopper transmission as a function of neutron wavelength. The resolution of a Fermi chopper time-of-flight spectrometer is examined and a method of calculating the exact resolution of a chopper having off-axis slits is shown. An experimentally simple method for the determination of the amount of ozone formed when liquid nitrogen is placed in a radiation field has been developed. The results of this method are compared to the results obtained using the usual methods of chemical analysis. The method utilizes Drager Gas Analysis Tubes to determine the amount of ozone present in the exit gas and this result is used to calculate the amount of ozone present in the liquid nitrogen. Some experimental results obtained using the Missouri University time-of-flight spectrometer are presented and compared to previous results. The range of applicability of such instruments is discussed. (Diss. Abstr. Int., B)

15978 IMPROVEMENTS IN RADIATION PYROMETERS. Nicklin, Alan William; Nicod, Alfred Richard Eugene (to United Kingdom Atomic Energy Authority). British Patent 1,212,685. 18 Nov 1970. Filed 6 Mar 1968.

Reference is made to pyrometers for use in nuclear reactors. The instrument described comprises an evacuated chamber having a window for passage of radiation from the body whose temperature is to be measured into the chamber. Two radiation receiving disks are provided within the chamber, each with a thermocouple hot junction attached. A thermal insulating screen is located in the radiation path to one of the disks, and means are provided for comparing the outputs of the thermocouples and determining the value of the thermal radiation common to both disks. The hot junctions are preferably series opposed so that the EMF of one counters that of the other, thereby cancelling the response due to the ionizing component which is common to both disks. It is desirable to shroud the pyrometer by a heating net so that periodic calibration can be made in the operating position. (UK)

15979 COMPUTER ACQUISITION OF NUCLEAR DATA. Caelli, W. J.; Hebbard, D. F.; Lamberth, W. J.; Ophel, T. R. (Australian National Univ., Canberra). pp 557-64 of Proceedings of the Fourth Australian Computer Conference, Adelaide, South Australia, 1969. Vol. 1. Adelaide; Australian Computer Society Inc. (1969).

See CONF-690837.

An approach to use of a process computer for acquisition, control, analysis and general data transmission in the research laboratory is described, together with the interface hardware, the system concepts and their use in real-time interaction with an experiment. (Australia)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 15962, 17272, and 17290.

15980 (N-70-36928) CHARGED-PARTICLE RADIATION DAMAGE IN SEMICONDUCTORS. XV. STUDY AND DETERMINATION OF AN OPTIMUM DESIGN FOR SPACE UTILIZED LITHIUM DOPED SOLAR CELLS. PART 1. Interim Final Report. Downing, R. G.; Carter, J. R.; Scott, R. E.; Van Atta, W. K. (TRW Systems Group, Redondo Beach, Calif.). 19 Jun 1970. Contracts NAS7-100; JPL-952554. 95p. (NASA-CR-112867; TRW-13154-6011-RO-00(Pt.1)). NTIS.

For Jet Propulsion Lab., Pasadena, Calif.

Hall coefficient measurements were made on lithium-doped silicon having dopant concentrations comparable to those found in solar cells. The results of the measurements of these materials indicate that two defect complexes are formed during irradiation. The E sub c-0.17 eV acceptor (oxygen-vacancy pair) is one of these defects. The other defect is associated with a deeper lying energy level which may be a lithium-vacancy pair; this level is found only in float-zone silicon. Capacitance measurements on irradiated lithium-doped solar cells were made as a function of voltage and frequency. This work indicates that irradiation of quartz crucible silicon solar cells results primarily in the formation of E sub c-0.17 eV acceptor defects. These defects are later annihilated by reaction with lithium donors. Lithium compensated p-type silicon was irradiated and the electrical measurements suggest that lithium reacts with radiation defects in a manner which may provide a hardening effect on n/p solar cells. A study was performed to evaluate the effectiveness of bismuth and tin doping to achieve radiation hardness with negative results. (auth) (STAR)

15981 (SC-RR-70-853) PERMANENT NEUTRON DAMAGE IN PIN MICROWAVE DIODE SWITCHES. Chaffin, R. J. (Sandia Labs., Albuquerque, N. Mex.). Dec 1970. 44p. Dep. NTIS.

The microwave PIN diode and its associated circuitry were studied both experimentally and theoretically. The results show that microwave PIN switches are very susceptible to permanent neutron damage. The failure mechanism is a severe reduction of conductivity modulation in the I region of the diode caused by a reduction of carrier lifetime. This loss of conductivity modulation not only causes a reduction of the isolation abilities of a microwave switch, but also leads to other secondary failure modes that can be extremely important. (auth)

15982 (WHAN-SA-10) EFFECTS OF FAST NEUTRON IRRADIATION ON THERMOCOUPLES. Hoitink, N. C.; Weddle, R. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 7 May 1970. Contract AT(45-1)-1830. 14p. (CONF-700713-1). Dep. NTIS.

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif.

As part of a program aimed at establishing performance characteristics of thermocouples to assure reliable sensors for measuring coolant temperature in the Fast Test Reactor (FTR) thermal and nuclear environment, 22 Chromel/Alumel thermocouples have been tested before and after exposure in the EBR-II nuclear reactor. Neutron exposure totaled about 1×10^{21} nvt (>0.18 MeV) with an irradiation temperature of 1050°F. The 30-in. long, 0.0625-in. diameter, stainless-steel-sheathed, MgO-insulated thermocouples included both grounded- and insulated-junction types. Very little information exists regarding fast neutron exposures beyond about 10^{20} nvt, and since thermocouples for use in the FTR may experience exposures between 10^{21} and 10^{22} nvt, the described program emphasizes the determination of the type and extent of fast neutron damage. Effects on the sensors from fast neutron irradiation may include calibration shifts, wire resistance changes, response time changes, and variations in insulation resistance. (auth)

15983 (WHAN-SA-18) IN-VESSEL DETECTOR CABLES: SIGNALS OR NOISE? Porter, N. S.; Hoitink, N. C.; Jackson, C. N. Jr. (WADCO Corp., Richland, Wash.). 16 Sep 1970. Contract AT(45-1)-2170. 18p. (CONF-700904-4). Dep. NTIS.

From Conference on Power Reactor Systems and Components, Williamsburg, Va.

Several coaxial cables are investigated under the conditions of reactor cores: high gamma fluxes and temperatures near 1200°F. The exact mechanisms of cable failure by breakdown pulse remain unknown, but it is concluded that the type of dielectric is definitely a factor. (R.W.R.)

XUM

15984 INFLUENCE OF IRRADIATION UPON THE LEAKAGE CURRENT OF ELECTROLYTIC CAPACITORS. Wolschendorf, K. (Univ., Kiel). Atomkernenergie; 16: 177-81(1970).

Wet aluminium electrolytic capacitors were subjected to x-ray irradiation and the radiation induced increase in leakage current was studied. The influence of capacitance, temperature, and voltage upon the radiation effect was investigated. It turned out that the observed increase in leakage current cannot be explained as a photoconductivity effect upon the shunting leakage resistor of the capacitor but is due to a photovoltaic effect which occurs obviously in the aluminium oxide. From the results of the irradiation experiments conclusions were drawn concerning the structure and the conduction mechanism in the anodic oxide layer. (auth)

15985 CHANGE OF CARRIER DIFFUSION LENGTH IN DAMAGED SILICON SOLAR CELLS. Usami, Akira (Nagoya Inst. of Tech., Japan). Denshi Tsushin Gakkai Ronbunshi, C; 53: 363-9(Jun 1970). (In Japanese).

The degradation rate of the carrier diffusion length of the γ-irradiated silicon solar cells has been estimated by change of the matching load resistance (R_{mp}) of the cells. The degradation tendency of the carrier diffusion length obtained by the numerical analysis using experimentally obtained voltage or the current at some external load resistances is much similar to those of the experimentally obtained results. These degradation rates are similar to those of the values obtained by the changes of the short-circuit current. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 16278, 16307, and 16336.

Basic Processes

Refer also to abstract 16341.

15986 (STI/DOC-10/121) FERTILIZER MANAGEMENT PRACTICES FOR MAIZE: RESULTS OF EXPERIMENTS WITH ISOTOPES. Results of a Four-Year Co-Ordinated Research Programme of the Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture. Technical Reports Series No. 121. (International Atomic Energy Agency, Vienna (Austria)). Oct 1970. 78p. IAEA $3.00.

The Joint FAO/IAEA Division, in cooperation with scientists in eight countries, conducted coordinated field experiments with maize using isotopically labeled N- and P-fertilizers during the period 1964–68 inclusive. In each year of the program the same experimental treatments and techniques were used in each experiment in order to enable the significance not only of the treatments but also the effect of the widely differing soil and climatic conditions on their effectiveness to be evaluated. The primary objective of the four-year coordinated maize fertility experiments was to assess the applicability of selected fertilization practices for maize grown in different areas of the world. Perhaps an equally significant objective of the experiments was to provide quantitative information, previously not available, on the level of efficiency of use of nitrogen fertilizer by maize grown on typical maize-growing areas in selected developing countries. The data obtained during the four-year program clearly demonstrated the contrasting results that can be expected depending on the environmental and soil conditions existing at an individual plot site. The following generalizations must not be considered as applicable to any one particular site but as general guidelines conducive to sound fertilizer practices for maize fertilization. Applications of a part of the fertilizer N, applied together with the phosphorus in a band adjacent to the row at time of seeding, markedly accelerated the uptake of fertilizer phosphorus but did not affect the efficiency of uptake of fertilizer nitrogen; Plough-down of a part or all of the fertilizer nitrogen at time of seeding was considerably less effective than band applications; split applications of the fertilizer nitrogen are highly desirable; an incremental application in a band at time of seeding is essential. Subsequent applications can be made any time up to the tasselling stage with equal effectiveness; the nitrogen carriers $(NH_4)_2SO_4$, NH_4NO_3 and $(NH_2)_2CO$ were shown to be equally effective in supplying the nitrogen to the growing maize both when banded at seeding time or side-dressed at a later growth stage; maize grain yields were increased substantially (37% on the average) with optimum N-fertilizer management practices; the uptake of soil nitrogen by the maize plants was in general unaffected by N-fertilization; conversion of fertilizer nitrogen into maize grain protein ranged widely depending on location and fertilizer practice employed, but for optimum fertilizer management averaged approximately 25%; crop utilization of fertilizer nitrogen (grain plus straw) averaged close to 40% for the four-year program, but ranged from a low of 20 to 70%, depending on soil and climatic conditions; n-fertilizer significantly increased the N-content of forage samples, but did not consistently change that of the grain or straw. (auth)

15987 SIMPLE CLINICAL METHOD FOR ESTIMATING THYROXINE SECRETION RATE. Harland, W. A.; Orr, J. S. (Univ. of Glasgow). Acta Endocrinol.; 66: 131-6(1971).

A simple method for measuring thyroxine secretion rate (T_4SR), suitable for use in routine clinical practice was presented. T_4SR equals 4.6 times the inverse of the plasma specific activity on the seventh day after administration of a single tracer dose of radiothyroxine. Data indicating the reliability of the method were presented and the theoretical basis was fully discussed. A detailed procedure was provided. (auth) (Denmark)

15988 WHOLE BODY AUTORADIOGRAPHIC STUDIES ON THE DISTRIBUTION OF RADIOISOTOPES. XXIII. INFLUENCE OF THE BREMSSTRAHLUNG EMISSION ON TRITIUM AUTORADIOGRAPHY. Otsuka, Minezo; Sakuma, Mari; Sato, Yoshishige (Tanabe Seiyaku Co., Ltd., Saitama, Japan). Radioisotopes (Tokyo); 19: 518-24(Nov 1970). (In Japanese).

The whole body autoradiograms of mice which had received injections of ^3H- and ^{14}C-labelled compounds were obtained by making close contact between the film and the body section or the film and the cellophane tape which covered the section surface. On the film which had been in contact with cellophane tape of 60 μ thick, blackness was found on the spots corresponding to the dorsal subcutaneous tissue which had received the injection of ^3H-labelled compound. This photographic black image seems to be abnormal considering the β-particles of tritium cannot have the maximum energy which is high enough to penetrate the thickness of the cellophane tape mentioned above. In an effort to find the cause of these abnormal images, experiments were carried out under various conditions of exposure. Both x-ray and color films were employed. As a result of these experiments, it was concluded that the image obtained is not made by the direct action of β radiation of tritium on the emulsion, but by the interaction between tritium radiation and cellotape, and it was assumed that the Bremsstrahlung emission produced by the interaction between tritium radiation and cellophane tape caused the blackness on films. This Bremsstrahlung emission was also observed in other shielding materials, for instance, Al foil, glass plate, carbon paper, scotchtape and lumilar sheet. (auth)

15989 RADIOLABELING DERMACENTOR VARIABILIS WITH ^{90}Sr AND ^{90}Sr PLUS ^{14}C MIXTURES. Sonenshine, Daniel E.; Esch, Gertrude (Old Dominion Univ., Norfolk, Va.). J. Econ. Entomol.; 63: 1635-8(Oct 1970).

The feasibility of labeling larval American dog ticks, Dermacentor variabilis (Say) with ^{90}Sr was demonstrated. The radioisotope was administered in inorganic form by inoculation of procreant females. Transovarial transfer to larval progeny resulted in sufficient radioactivity to permit easy detection of labeling in individual larvae. Double labeling of D. variabilis with both ^{14}C and ^{90}Sr was done by inoculations of mixtures of ^{14}C-glucose and inorganic ^{90}Sr into the engorged parents. Detection of these double-labeled ticks and discrimination of such individuals from either ^{14}C- or ^{90}Sr-labeled ticks was done with the aid of a 2-channel liquid scintillation detector. The advantages of increasing the variety of radioisotope labels available for radioecological research with ticks were discussed. (auth)

15990 HEMOPOIETIC CELLULAR PROLIFERATION. Symposium Held at Boston, Massachusetts, November 5–6, 1969. Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970). 343p. $19.75. (CONF-691107).

Thirty papers were presented at the conference. Separate abstracts were prepared for 16. Topics included the control of erythropoiesis, granulopoiesis and thrombopoiesis, consideration of the pluripotential stem cell and leukemia. (F.M.M.)

For abstracts of individual chapters see: 15991, 16228, 16280, and 16336–16348.

15991 THROMBOPOIESIS AND THROMBOPOIETIN. Levin, Jack (Johns Hopkins Univ., Baltimore). pp 299-309 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

The rate of appearance of selenium-75-labeled selenomethionine in circulating platelets of rabbits following intravenous administration was studied. The effects of acute hemorrhage and hypertransfusion of platelets were also investigated and it was suggested that incorporation of the isotope is a more sensitive indicator of altered platelet production than is the platelet count. The results are compatible with a feedback mechanism by which circulating platelets affect the rate of thrombopoiesis. The concept of a humoral agent, namely thrombopoietin, that acts on megakaryocytes to regulate platelet production is supported. (F.M.M.)

15992 HIGH RESOLUTION AUTORADIOGRAPH AND ITS QUANTITATIVE USE. Watanabe, Ikuo (National Inst. of Radiological Sciences, Chiba, Japan). Hoshasen Kagaku; 12: 185-9 (Dec 1969). (In Japanese).

Cell labeling techniques were used for determining the resolving power of an autoradiograph. The measurement of silver grains in studies on DNA synthesis and thymidine production in mammalian cells is discussed. The correlation between thymidine produced intracellularly and externally supplied labeled thymidine was studied. It was found that external irradiation of cells with various doses did not change the quantity of thymidine produced within the cells. Radiation damage to DNA of bacteria caused excision. Quan-

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titative measurements by autoradiograph include the Stubblefield method developed for counting the silver grains in chromosome units, the Roger method for counting silver grains in cell units, and the automatic measurement of silver grains developed on a trial basis. The latter method has the advantage of making it possible to make direct counts of silver grains. (Japan)

15993 TAGGING 7μ MONODISPERSE POLYSTYRENE PARTICLES WITH ^{11}C. Philipson, Klas; Camner, Per; Svedberg, John (Karolinska Institutet, Stockholm. Uppsala Univ.). Int. J. Appl. Radiat. Isotop.; 21: 639-42(Nov 1970).

Monodisperse particles of polystyrene were tagged with ^{11}C by irradiation with 50 MeV protons. A specific activity of approximately 100 μCi/mg was obtained without the individual particles being visibly affected or tending to cluster. Leakage of the tagging nuclide was very slight and the purity satisfactory. The particles of polystyrene tagged with ^{11}C were therefore considered to give a suitable test aerosol for studies of tracheobronchial deposition and the first hours of lung clearance in man. (auth) (UK)

15994 SIMPLIFIED PROCEDURE FOR THE PREPARATION OF ^{131}I-LABELLED SULFOBROMOPHTHALEIN. ITS APPLICATIONS TO LIVER SCANNING. Suwanik, Romsai (Siriraj Hospital, Bangkok); Tubis, Manuel; Viranuvatti, Vikit; Limwongse, Kasem. Nucl.-Med.; 9: 268-74(30 Sep 1970).

A method for preparing ^{131}I-labeled sulfobromophthalein is described. The method is simple and inexpensive. The labeled compound is of particular value where ^{99m}Tc-labeled preparations for liver scanning are too expensive or not readily available. It has been used as a liver scanning agent with satisfactory results, revealing both morphological as well as functional abnormalities in various liver conditions in the same manner as ^{131}I-labeled Rose Bengal. Its use in liver scanning has been extended to the visualization of the liver abscess cavity after intracavitary injection. The method has been used to observe the changes in size and configuration of the abscess cavity during its course of healing under medical treatment. Another extension of the work is the intraductal administration of the labeled compound via a T-tube to demonstrate the dilatation of the biliary tract in cases of advanced opisthorchiasis. The application of the labeled compound to liver scanning is illustrated. (auth)

15995 MATHEMATICAL MODEL TO AID IN THE INTERPRETATION OF RADIOACTIVE TRACER DATA FROM PROLIFERATING CELL POPULATIONS. Fried, Jerrold (Sloan-Kettering Inst. for Cancer Research, New York). Contract AT(30-1)-910. Math. Biosci.; 8: 379-96(Aug 1970).

A mathematical model of a proliferating cell system is presented which was derived specifically with experimental applications using radioactive tracers in mind. The model is flexible in that the same basic model can be used to interpret the data from a single experiment or from several different ones. In its most general form the model enables the determination of cell cycle variability, the fraction of dormant or nonproliferating cells, and the rate of cell death. The basic approach is to derive theoretical expressions for the experimentally observed phenomena in terms of the unknown parameters of the model. The values of the parameters can then be determined by numerical techniques after setting the theoretical expressions equal to the corresponding observed values. Some specific suggestions for using this method are presented. (auth)

15996 PENETRATION OF RADIOACTIVE CALCIUM INTO THE AQUEOUS AND CORNEA OF NORMAL AND ALLOXAN-TREATED RABBITS. Obenberger, Jiri; Babicky, Arnost (Insts. for Biologic Research, Prague). Amer. J. Ophthalmol.; 70: 1003-5(Dec 1970).

A cup with repeatedly prepared solution of alloxan was held on the intact eye of chinchilla rabbits for 30 min. On the seventh day, penetration of an intravenously injected solution of $^{45}CaCl_2$ (100 μCi/kg) into the aqueous and corneas of treated and control rabbits was followed. After 2 hr, the animals were killed. Activity of the aqueous of alloxan treated eyes showed significantly higher values in comparison with controls, 1.87 ± 0.04 and 1.53 ± 0.14, respectively. The weight of alloxan treated corneas significantly exceeded the weight of the controls, 177 ± 6 and 73 ± 2, respectively. In the hydrated corneas approximately the same activity (calculated on their wet weight) as in controls was counted. The activity of the central trephined parts of the cornea in both groups was a little increased in comparison with the corneal periphery. (auth)

15997 MEASUREMENT OF TRANSPIRATION IN TROPICAL TREES WITH TRITIATED WATER. Kline, J. R.; Martin, J. R.; Jordan, C. F.; Koranda, J. J. (Argonne National Lab., Ill. Univ. of California, Livermore). Ecology; 51: 1068-73(Autumn 1970).

The measurement of transpiration of water by trees in the field with tritiated water as a tracer depends upon a new application of established theory of radionuclide dynamics in steady-state systems. The techniques required are non-destructive to the trees and probably have negligible disturbing effects on transpiration. Average transpiration rates ranging from 1.75 to 372 liters per day per tree were measured by the proposed method on tropical forest trees which ranged from the understory to the canopy in size. Statistical errors range from 12.1% on the largest tree to 6.2% on the smallest for one standard deviation. Non-random sources of error in the method may include loss of tritium from leaves due to rainfall; and possible enrichment of tritiated water in leaves due to differences in vapor pressure and molecular diffusion coefficients between tritiated water and ordinary water. These require further experimental evaluation. The method may be generally applicable to field measurements of transpiration in trees. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 15776, 16063, 16066–16069, 16076, 16081, 16086, 16092, 16121, 16125, 16127, 16148, 16172, 16253, 16306, and 16320.

15998 (NIRS–9, pp 63-82) ENVIRONMENTAL STUDIES. (National Inst. of Radiological Sciences, Chiba (Japan)).

From Annual Report, 1969–1970.

The uptake and retention of ^{85}Sr in man following a single intravenous or oral administration were measured using whole-body counting, linear scanning, and analysis of feces and urine for 20 days. The data were used to derive biological constants for ^{85}Sr metabolism in Japanese. The concentration factors for ^{137}Cs and ^{85}Sr in the common sea bass (Lateolabrax japonicus), the crimson sea bream (Euynnis japonicus), and fasciatus (Oplegnathus fasciatus) were measured as a function of age, organ, and species following the addition of tracer amounts to a seawater aquarium. (C.H.)

15999 (NP–18392) DISSERTATION ON THE NECESSARY CRITERIA FOR THE DEVELOPMENT AND INTERPRETATION OF A TEST IN NUCLEAR MEDICINE. Munoz Acevedo, Evaristo (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Medicina). 1970. 61p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

Thesis.

The total water in six volunteers of the male sex was determined using tritiated water. The physiological laws which govern the water metabolism and the relative pathology were revised. The outstanding aspects in the realization of the tests were discussed. The literature data, in which water represents 55.34 ± 5.31% of the body weight, were compared with the test results and the agreement was good. The method, based on the activity of the urine over a 24 hr period after drinking tritiated water, is simple and precise. (tr-auth)

16000 (ORO–678, pp 14-24) FETAL PHYSIOLOGY AND PLACENTAL TRANSFER. Wykoff, M. H. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1–December 31, 1969.

The movement and distribution of ^{134}Cs, ^{85}Sr, and ^{47}Ca in pregnant female rats and fetuses were investigated. Following subcutaneous injection of ^{134}Cs on the 13th, 15th, 17th, and 19th day of gestation, it was found that there was a shift of ^{134}Cs from the placenta to the fetus on subsequent days, and that pregnancy did not exert any effect on the maternal blood or uterus concentration. Strontium-85 was injected on the 11th through the 21st day of gestation and the distribution in maternal blood, uterus, fetus, and placenta was observed. Calcium-47 and ^{85}Sr were given on the 15th day of gestation and samples of maternal blood, uterus, kidney, bone muscle, fetus, and placenta were analyzed. The calcium concentration was found to be higher in all the maternal tissues with the exception of kidney and bone. (H.L.W.)

16001 (ORO–678, pp 83-8) MINERAL METABOLISM IN CATTLE. MEASUREMENT OF RATE OF PASSAGE THROUGH THE BOVINE DIGESTIVE TRACT USING RADIOACTIVE MARKERS. Miller, J. K. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1–December 31, 1969.

Tracer levels of ^{144}Ce and ^{46}Sc were administered orally and intravenously to calves. Blood samples were taken at intervals, and calves were killed 72 hrs after intravenous injection and eight days after oral administration. Digestive tracts and other organs were removed and contents were sampled. Neither ^{46}Sc nor ^{144}Ce was detected in blood or urine after oral dosage. The intravenous ^{144}Ce dose was followed by low urinary excretion and rapid blood clearance. Urinary excretion of ^{46}Sc after an intravenous dose was also negligible. The small intestine appeared to be the main route

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of entry of intravenous doses into the digestive tract. Gastrointestinal distribution of daily administered ^{46}Sc and ^{144}Ce were almost identical. Cerium-141 and ^{144}Ce were used as markers to follow passage of undigested residue in 18 calves. A table is presented to show recovery of radiocerium in contents of various sections of the calf digestive tract and in feces at different times after dosing. (H.L.W.)

16002 (ORO-678, pp 94-101) METABOLISM OF FISSION PRODUCTS AND RELATED NUCLIDES IN POULTRY. Mraz, F. R. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). From Annual progress report, January 1–December 31, 1969.

Chickens were perfused with various doses of ^{45}Ca and ^{85}Sr. The birds were killed immediately after perfusion and the ^{45}Ca and ^{85}Sr contents of the perfusates and cellular particulates of the intestinal mucosa determined. Tabulated results show that more ^{45}Ca was absorbed than ^{85}Sr with the 125 mM levels having the greatest effect on the ratios and total uptake. Strontium tended to increase uptake of both ^{45}Ca and ^{85}Sr in immature pullets. Radionuclide uptakes by non-laying hens and immature pullets were significantly lower than those of the laying hens. The higher ratios of Sr : Ca observed in the nuclear, mitochondrial, and microsomal fractions of the jejunum and ileum of laying hens indicated that ^{45}Ca was leaving these particulates at a more rapid rate than ^{85}Sr. The effect of increasing the levels of alkaline earths was dependent upon the alkaline earth perfused and the intestinal section considered. (H.L.W.)

16003 (RA-41) ^{90}Sr AND ^{137}Cs IN THE HUMAN DIET IN THE NETHERLANDS DURING 1969. Mattern, F. C. M.; Drost, R.; Strackee, L. (Rijks Instituut voor de Volksgezondheid, Utrecht (Netherlands)). Oct 1970. 26p. Dep. NTIS (U. S. Sales Only).

Results of measurements of ^{90}Sr and ^{137}Cs in a number of foodstuffs are reported. The yearly mean of the daily dietary intake of ^{90}Sr and ^{137}Cs in the Netherlands is estimated as 11.2 and 27 pCi/day. (auth)

16004 (RT/PROT-(70)10) EXPOSURE OF WORKERS TO PLUTONIUM: PHYSIOPATHOLOGICAL AND THERAPEUTIC NOTES. Bianco, A. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari). [1967]. 10p. (In Italian). (CONF-681047-2). Dep. NTIS (U. S. Sales Only).

From 31st Conference of the Italian Industrial Medical Society, Bologna, Italy.

Physico chemical, physiological, and toxicological data on ^{239}Pu are summarized. Current views on Pu exposure of workers, radiation protection, and therapeutic procedures for removal of Pu contamination are described and discussed. (auth)

16005 DEPENDENCE OF BEHAVIOR OF RADIOISOTOPES IN THE ORGANISM UPON THE PHYSICO-CHEMICAL CHARACTERISTICS. Dubrovina, Z. V.; Sokov, L. A. (Moscow Inst. of Biophysics). Med. Radiol.; 15: No. 10, 41-7(Oct 1970). (In Russian).

A correlation between a number of parameters of exchange of radioisotopes of different groups and subgroups of the periodical system and the value of their ionic radius and hydration energy is discussed. Differences in absorption from the gastrointestinal tract, deposition in the liver and skeleton, and rate of elimination from the muscles and skeleton are analyzed. (auth)

16006 WHOLE-BODY RADIOMETRIC INVESTIGATION OF THE ASSIMILATION OF ^{59}Fe AFTER OPERATIONS ON THE STOMACH. Kaplan, M. A.; Gabuniya, R. I.; Berdov, B. A. Med. Radiol.; 15: No. 10, 59-63(Oct 1970). (In Russian).

Assimilation of ^{59}Fe in 69 patients at remote periods after different stomach operations is discussed. The results of the investigation showed that there exists a correlation between ^{59}Fe assimilation and the character of the operation performed and the presence of hemorrhages from the gastrointestinal tract. (auth)

16007 INTERACTION OF TEMPERATURE, AGE, AND SEX ON THE RETENTION OF RADIOCESIUM BY RATS. Lengemann, F. W. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-4039. Health Phys.; 19: 785-90(Dec 1970).

The investigation was concerned with the effect of age, sex, and temperature and their interactions on the fractional retention of a single dose of radiocesium by rats. The first experiment performed verified observations that rats kept at 4°C retained less radiocesium than rats at 21° and 32°C and provided preliminary evidence that a difference existed between male and female rats in their fractional retention of radiocesium at 4°C. In the second experiment young and adult male and female rats were kept at 4° and 32°C and the retention of a single dose of ^{134}Cs followed. It was found that the lower temperature resulted in a lesser fractional retention of cesium and that within a given temperature the young rats retained less ^{134}Cs than did the adult rats. At 32°C there was no difference between males and females within an age group but at 4°C the young males had a lower body burden of radiocesium than the young females while adult females had less radiocesium than adult males. In the third experiment intact rats were compared to castrated rats kept under the same environmental conditions. At 32°C no differences were seen among the four groups. At 4°C intact females contained less radiocesium than all other rats with intact and castrated males having about the same body content of ^{134}Cs. At 21°C the same general order prevailed but differences were less marked. Equations for the data of experiments 1 and 2 are presented and are discussed in relation to the changes seen. (auth) (UK)

16008 SOME ASPECTS OF DOSIMETRY IN MINIATURE SWINE CHRONICALLY INGESTING ^{90}Sr. Palmer, R. F.; Thomas, J. M.; Watson, C. R.; Beamer, J. L. (Battelle-Northwest, Richland, Wash.). Health Phys.; 19: 775-83(Dec 1970).

Gompertz growth curves were fitted to both skeletal growth and skeletal ^{90}Sr accumulation data from miniature swine ingesting from 1 to 125 μCi ^{90}Sr/day from birth to nearly 8 yr of age. Normalized ^{90}Sr accumulation data from the animals ingesting 1, 5, or 25 μCi per day were adequately described by a single equation. Those from the 125 μCi/day animals, however, required a different equation to reflect their increased absorption and/or retention of ^{90}Sr that apparently resulted from radiation damage. Derived equations expressing ^{90}Sr concentration in skeleton vs. age peaked at about 9 mon. of age and then decreased to a plateau. This resulted from the ^{90}Sr content of the skeleton plateauing earlier in life than did skeletal weight. Utilization of these equations and appropriate factors permitted calculation of the cumulative ionizing radiation dose delivered to bone over the lifetime of the animals. Two complimentary studies were conducted to better define the radiation dose to bone surfaces and fetuses of these animals. (auth) (UK)

16009 ESTIMATION OF ^{241}Am BODY BURDENS BY ANALYSIS OF WHOLE-BODY SCANNING, EXCRETA, AND BODY WEIGHT DATA. Thomas, R. G. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Health Phys.; 19: 751-5(Dec 1970).

Beagle dogs were exposed by inhalation to an aerosol containing ^{241}Am and a study conducted to establish some reliable method for quantitating ^{241}Am body burdens in accidentally exposed persons. A combination of whole-body scanning and excreta analysis was used to determine initial body burdens. Two dogs were sacrificed, at 127 and 256 days, and tissue analyses used to verify the integrity of the method described to determine initial body burden. A correlation was also derived between body-weight changes and alterations in whole-body counting efficiency, treating the dog as a simple cylinder. The change in thickness of the chest wall (as related to the diameter of a cylinder) and the accompanying variation in photon detection ability are implicated. The need for more detailed information to relate to accidentally exposed humans is emphasized. (auth) (UK)

16010 ^{131}I IN CHILDREN'S THYROIDS. Nelson, I. C. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys.; 19: 832-4(Dec 1970).

Results were presented of ^{131}I uptake in children's thyroids in late 1962, a period of moderate radioactive fallout. At that time, milk averaged 40 pCi ^{131}I per litre. It was shown that the intake was about 24 pCi ^{131}I per day and thus, assuming the ICRP recommended biological half life of 7.6 days for ^{131}I in the thyroid, an uptake of about 25% is implied. (UK)

16011 NATURAL THORIUM IN HUMAN BONE. Lucas, Henry F. Jr.; Edgington, David N.; Markun, Frank (Argonne National Lab., Ill.). Health Phys.; 19: 739-42(Dec 1970).

The ^{232}Th concentration in rib bone from 38 humans ranged from <0.1 to 72 ng/g ash. Values increased with age and were fitted by the expression $Y = (0.16 \pm 0.02)T$ where Y is the ^{232}Th concentration in ng/g bone ash and T is the age in years. Evaluation of the retention of the ^{228}Ra produced by the decay of ^{232}Th is not possible for human exposure to environmental sources since direct intake of naturally occurring ^{228}Ra is too large. (auth) (UK)

16012 RELATIVE DISTRIBUTION OF PLUTONIUM AND AMERICIUM FOLLOWING EXPERIMENTAL PuO_2 IMPLANTS. Johnson, L. J. (Colorado State Univ., Fort Collins); Watters, R. L.; Lagerquist, C. R.; Hammond, S. E. Health Phys.; 19: 743-9(Dec 1970).

Dogs with simulated puncture wounds contaminated with reactor

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produced PuO_2 were studied to determine the relative translocation of Pu and Am. Differential distribution of the two elements was observed in both soft and skeletal tissues. Administration of the chelating agent diethylenetriaminepentaacetic acid, DTPA, produced significant effects in the relative concentration of Pu and Am in urine, liver, and femur bone tissues. In-vivo determination of Pu burdens by the ^{241}Am tracer method may produce inaccurate results. (auth) (UK)

16013 BODY ELIMINATION RATES OF ^{134}Cs, ^{60}Co, AND ^{203}Hg. Morsy, S. M.; El-Assaly, F. M. (Atomic Energy Establishment, Cairo). Health Phys.; 19: 769-73(Dec 1970).

The Inshass whole-body counter with a NaI(Tl) crystal of 20 cm dia. by 10 cm thick was used to measure whole body retention of three radioactive elements ^{134}Cs, ^{60}Co and ^{203}Hg which were incorporated by three normal subjects. The biological half-lives were determined for the three radioactive elements and compared with values reported by previous authors. For ^{60}Co the relative dose contribution to the total dose from each component of the retention curve was calculated. Also the total dose commitment for the subject during a 50 yr period was calculated for each subject. (auth) (UK)

16014 MALIGNANT TUMOUR RISK FROM RADIUM BODY BURDENS. Goss, S. G. (Radiological Protection Service, Sutton, Eng.). Health Phys.; 19: 731-7(Dec 1970).

The incidence of malignant tumors in persons with radium body burdens was studied by workers at M.I.T. and A.N.L. They gave large safety factors for the present MPL of 0.1 μCi ^{226}Ra and implied that there is a practical threshold at a higher level. A reanalysis of their data shows it is not safe to assume that the cases examined adequately represent the population at risk and other interpretations of the data ought to be considered. Since a high proportion of the cases are still living, many of the histories are not yet complete and the higher than expected incidence of central nervous tumors in the A.N.L. series suggests that the range of radium induced malignancies may be wider than that normally assumed. Criticisms are made of the way dose/response models are chosen and tested in the M.I.T. reports. A treatment of the data in line with that used by the M.I.T. group is described which shows that the risk at 0.1 μCi ^{226}Ra could be at the same level of risk as that experienced at the MPL for external radiation. It is concluded that for radiation protection purposes there is no reason to believe the present MPL is set too low. (auth) (UK)

16015 DISTRIBUTION OF ^{239}Pu IN THE BONE MARROW AND ON THE ENDOSTEAL SURFACE OF THE FEMUR OF ADULT RABBITS FOLLOWING INJECTION OF $^{239}Pu(NO_3)_4$. Bleaney, Betty; Vaughan, Janet (Churchill Hospital, Oxford). Brit. J. Radiol.; 44: 67-73(Jan 1971).

A study was made of the distribution of ^{239}Pu in the bone marrow and on the endosteal bone surfaces of adult rabbits following both the intramuscular and intravenous injection of $^{239}Pu(NO_3)_4$. Differences in the marrow distribution could be attributed to differences in the colloidal character of the plutonium reaching the marrow, depending on the route of injection. Examination of the distribution of the ^{239}Pu, as seen in the heavy band of α tracks on the endosteal surface both of the bone after removal of the marrow and on the extruded marrow, showed that approximately 40 percent was present in or on the endosteal cells and 60 percent was present on the mineral or matrix of the bone surface free of cells. The amount of ^{239}Pu in the endosteal cells varied in a similar manner with time after injection to the amount of ^{239}Pu on the mineral surface. The presence of ^{239}Pu in the osteogenic cells themselves could account for the great carcinogenicity of this radionuclide. (auth) (UK)

16016 CONSIDERATIONS IN ANALYSIS OF BREATH $^{14}CO_2$ DATA. Winchell, H. S.; Wiley, K. (Univ. of California, Berkeley). Contract W-7405-eng-48. J. Nucl. Med.; 11: 708-10(Dec 1970).

The rate at which $^{14}CO_2$ is measured in expired air after intravenous administration of ^{14}C-labeled materials is a function of the physical parameters involved in delivery and removal of the material to and from metabolic sites, the kinetics of the metabolism of the material, the delays related to passage of $^{14}CO_2$ from its production site across the body's CO_2–HCO_3-pools before its expiration in the breath and the delays inherent in the measuring device from the time $^{14}CO_2$ actually appears in the breath and the time it is recorded. Previous experience with graphical analysis of breath $^{14}CO_2$ curves suggested that the late portion of the curve was suited to a series of exponential terms ($\Sigma_i A_i e^{-r_i t}$). In the present paper one of these terms was identified with the turnover rate of $^{14}CO_2$ in the measuring device employed while the remaining terms were identified with compartments involved in the metabolism of ^{14}C-labeled material being studied and the kinetics of the CO_2–HCO_3-pools which the labeled CO_2 must traverse before its expiration in the breath. To correct for digression of the observed data for idealized compartmental behavior, a function G(x) was defined. A method was presented for estimating the minimum length of time data must be collected to define the parameters of a given model and for estimating the number of compartments that must be postulated to explain a set of $^{14}CO_2$ data. (E.E.H.)

16017 UPTAKE OF ^{3}H-LABELLED TOLUIDINE BLUE AND NEUTRAL RED IN THE PARATHYROIDS OF THE DOG. Norman, E.; Seljelid, R.; Nakken, K. F. (Norwegian Radium Hospital, Montebello, Oslo). Scand. J. Clin. Lab. Invest.; 26: 369-71(Dec 1970).

The parathyroid uptake of ^{3}H-labeled toluidine blue and neutral red following i.v. injection in dogs has been studied. At different time intervals, the external parathyroids and samples from reference organs were removed for radioactivity determination. The mean uptake ratio per gram parathyroid/thyroid of toluidine blue was approximately 3. The mean ratio of parathyroid concentration to that of blood and muscles was 10 : 1. For neutral red, the mean parathyroid/thyroid ratio was 1.3 : 1. It is suggested that ^{75}Se-labeled toluidine blue may prove useful as a scanning agent for the parathyroids. (auth) (Norway)

16018 DISTRIBUTION OF INJECTED ^{59}Fe IN MICE. Smith, L. H.; Clayton, M. L. (Oak Ridge National Lab., Tenn.). Exp. Hematol.; No. 20, 82-6(1970).

Gross distribution of intravenously injected ^{59}Fe was determined in major organs of female $(C3H \times C57BL)F_1$ mice at several intervals during the first 24 hr after isotope injection. ^{59}Fe accumulated rapidly in erythropoietic tissue and in iron-storage sites. By 6 hr almost half of the injected ^{59}Fe was in hemopoietic tissue, and about one-third of the total ^{59}Fe incorporated by hemopoietic tissue was in the vertebral bone marrow. From data relating bone marrow cell number to ^{59}Fe incorporation by bone marrow, the number of hemopoietic cells in $(C3H \times C57BL)F_1$ mice was estimated to be 24.1×10^6 cells per gram of body weight. (auth)

16019 PROCEEDINGS OF THE FOURTH AUSTRALIAN COMPUTER CONFERENCE, ADELAIDE, SOUTH AUSTRALIA, 1969. VOLUME 1. TECHNICAL PAPERS. Adelaide; Australian Computer Society Inc. (1969). 599p. (CONF-690837).

Papers from the fourth Australian Computer Conference, held in Adelaide from 11th–15th August, 1969, are presented under the broad headings of Commercial, Industrial, and Management Topics; Computer Technology, Hardware and Software Topics; Scientific, Professional and Academic Topics. Three papers are given separate abstracts. (Australia)

For abstracts of individual papers see: 15979, 16020, and 18237.

16020 RANDOM ERROR AND TRUNCATION OF DATA IN EXPONENTIAL DECAY MODELS. Myhill, J. (Univ. of Sydney). pp 487-9 of Proceedings of the Fourth Australian Computer Conference, Adelaide, South Australia, 1969. Vol. 1. Adelaide; Australian Computer Society Inc. (1969).

See CONF-690837.

The use of compartmental models in the study of biological systems using tracers is described. The limitations occasioned by experimental error and observations and by truncation of data after a finite time are examined. Simulation involved computer generation of synthetic experimental data having different error levels and distributions and different degrees of truncation. The synthetic data were then analyzed by non-linear least squares fitting of exponentials. Results showed no significant variation over a number of error distributions, and contrary to the expectation of some experimentalists, the estimation error of parameters sometimes increased when observations were concentrated more in the initial rapidly changing part of the curve than in the later slowly changing portion. Gross underestimates of the fractional loss of tracer were obtained when two-compartment models were fitted to three-compartment data, and inter-compartment transfers were wrongly estimated. Tables are presented indicating the duration, spread, and accuracy of observations needed to obtain accuracy desired in parameter estimates. (Australia)

16021 METABOLISM OF HOMOLOGOUS ALBUMIN LABELLED WITH ^{131}I IN X-RAY-IRRADIATED RATS. Rzendowska, Franciszka; Gajewski, Antoni K.; Slowikowska, Maria G.; Budzynski, Andrzej Z.; Majle, Tadeusz (Warsaw Inst. of Radiological and Radiobiological Protection). Acta Physiol. Pol.; 21: 535-42 (Jul-Aug 1970). (In Polish).

The present study was aimed at investigating the changes in the following pools: general, intravascular, and extravascular, following injection of ^{131}I-labeled, homologous albumin, at various time intervals following x irradiation of the rats. 40 male rats of the Wistar strain were used for the experiments. Blood for the examinations was drawn 30 seconds, 2 min, and 1, 2, 3, 5, and 7 days after injecting the albumin. The results showed that the albumin is more rapidly removed from the circulatory system of the animals irradiated than in nonirradiated ones. The drop in the radioactivity of albumin in the blood of the animals irradiated is probably not only a result of its escaping from the vessels, but also a result of the penetration of albumin from the extravascular pool into the vessels and this, in consequence, causes the dilution of the blood becoming apparent in diminishing values of hematocrit in the animals irradiated. It was found that velocity of albumin decomposition was greater in irradiated animals than in nonirradiated ones, when the total amount of albumin in the organism of irradiated animals was even insignificantly greater than in control rats. The intensified catabolism in the irradiated organism is compensated by intensified synthesis. The conclusion was drawn that both the increase in the decomposition of albumin and in its synthesis began shortly after the irradiation of the organism. (P.B.M.)

16022 EFFECTS OF HYDROGEN-ISOTOPE LABELLING ON STEROID METABOLISM. Brodie, Harry J.; Hay, Cynthia E. (Worcester Foundation for Experimental biology, Shrewsbury, Mass.). Biochem. J.; 120: 667-9(1970).

Botryodiplodia malorum readily converts 17β-hydroxyoestr-4-en-3-one into the corresponding 1β-hydroxy compound. An attempt was made to obtain 1β-hydroxyoestr-4-ene-3,17-dione by incubation of oestrenedione (oestr-4-ene-3,17-dione), but it was found that the major product was 7β-hydroxyoestrenedione (30 to 40% yield). A 10% yield of 6β-hydroxyoestrenedione was obtained whereas only a 3% yield of the corresponding 1β-hydroxy compound was realized. When the substrate was labeled at the C-7β position with tritium and at C-4 with ^{14}C there was a marked increase in the $^{3}H/^{14}C$ ratio in the 6β-hydroxy compound. Similar results were obtained in competitive experiments with a mixture of unlabeled and 7β-deuterated oestrenedione. These results were interpreted to indicate that the hydrogen-isotope-labeled molecules were converted preferentially into 6β-hydroxyoestrenedione. (UK)

16023 CHARACTERISTICS OF IN VITRO COLONY FORMATION BY CELLS FROM HAEMOPOIETIC TISSUES. Bradley, T. R.; Metcalf, D.; Sumner, M.; Stanley, R. (Univ. of Melbourne). pp 22-35 of Hemic Cells in Vitro. /Farnes, Patricia (ed.). Baltimore; Williams and Wilkins Co. (1969).

From Symposium of the Tissue Culture Association, San Juan, Puerto Rico. See CONF-680635.

The characteristics of stimulation of colony formation in vitro from cells of mouse haemopoietic tissues were briefly reviewed. Mouse kidney or embryo feeder cells, media conditioned by the cells from these tissues, normal or leukemic mouse sera, sera from leukemic or infectious mononucleosis patients, human urine and mouse embryo extracts are all sources of colony stimulating activity and their properties have been described. All sources of colony-stimulating activity produce clones of cells of the granulocyte series. In tritiated thymidine treated mice injection of preparations rich in colony-stimulating activity has been shown to produce a neutrophil leukocytosis and accelerate the rate of accumulation of labelled neutrophils in the blood. It is suggested that the in vitro assay can detect factors capable of stimulating granulocyte development. (auth)

16024 DISTRIBUTION OF ^{137}Cs IN PREGNANT ANIMALS AND EMBRYOS. Hamada, Kazutaka (Osaka City Univ.). Sanfujinka No Shinpo; 21: 355-67(Jul 1969). (In Japanese).

Experiments were carried out to examine whether the passage of ^{137}Cs through the placenta was constant throughout the entire period of gestation in rats and rabbits. Distribution of ^{137}Cs in placenta, embryo, and amniotic fluid, as well as in various organs of the maternal body, was examined after administration of ^{137}Cs to rats having 14-day-old embryos in organ-forming stage and 19-day-old embryos in growth stage. Comparative examinations were also made on the relationship between the amount of potassium and distribution of ^{137}Cs in various tissues on the 19th day of gestation, and distribution of ^{137}Cs in the organs of pregnant and nonpregnant rats. The results indicated that ^{137}Cs was incorporated into the placenta within a short time after its administration to pregnant animals but its amount decreased gradually thereafter and the decrease became especially marked after 6 hrs. Levels of ^{137}Cs in the embryo reached a maximum 24 hrs after its administration to the mother. Transition of ^{137}Cs from the placenta to embryo increased with time during 24 hours after its administration and then neared equilibrium thereafter. ^{137}Cs transitted from maternal blood into the placenta and embryo against its concentration gradient. Concentration of ^{137}Cs in the amniotic fluid was very low, being $^{1}/_{7}$ that of the embryo in rats and $^{4}/_{1}$ in rabbits. Concentration of ^{137}Cs was higher in pregnant uteri than in non-pregnant uteri, the difference being statistically significant. (Japan)

Radiation Effects

Refer also to abstracts 15687, 16216, 16316, and 16321.

16025 (AD-713087) HISTOCHEMICAL STUDY OF LIVER ENZYMES INVOLVED IN GLYCOGEN METABOLISM IN THE X-IRRADIATED RAT. Catravas, G. N.; McHale, C. G. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Jun 1970. 24p. (AFRRI-SR-70-6). NTIS.

The liver enzymes responsible for the breakdown and synthesis of glycogen from glucose have been investigated cytochemically in rats exposed to 1200 rads of x rays. It was found that significant changes occur in their activities and that amylophosphorylase and amylo-1,6-glucosidase, both of which are responsible for the conversion of glycogen to glucose, are markedly inhibited by radiation. A significant inhibition of the activity of 1,4 to 1,6 transglucosidase (branching enzyme) was also observed. In contrast, the activity of UDPG-glycogen transglucosylase, which is responsible for the in vivo synthesis of 1,4-polysaccharides, was found to be enhanced. (auth) (USGRDR)

16026 (ORO-678, pp 74-7) METABOLIC EFFECTS OF SKIN RADIATION INJURY. Wade, Leo Jr.; Sasser, L. B.; Bell, M. C. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1-December 31, 1969.

Sixteen sheep were divided into two groups. One group served as controls while the other received an absorbed dose of 20,000 Rads to the skin from sealed ^{90}Sr-^{90}Y plaques. Body weight, complete hematology, concentration of iron, copper, zinc, and total protein in the plasma, erythrocyte copper and zinc concentration, total iron binding capacity of the plasma, and ^{65}Zn uptake by erythrocytes were measured at two-week intervals. Plasma iron concentration dropped sharply after irradiation. Plasma copper concentration in the irradiated sheep was significantly greater than that of control sheep at four weeks after irradiation. Total plasma protein levels in the irradiated sheep were significantly higher than in control sheep beginning six weeks after irradiation. In vitro incorporation of ^{65}Zn into erythrocytes of irradiated sheep was significantly greater than that of controls. None of the hematological values except platelets were affected by irradiation. Platelet levels began to rise shortly after irradiation. (H.L.W.)

16027 CERTAIN PECULIAR TRAITS IN THE CONTROL OF RNA BIOSYNTHESIS IN THE LIVER OF IRRADIATED ANIMALS. Todorov, I. N.; Paskevich, I. F. (Inst. of Medical Radiology, Kharkov. Inst. of Microbiology and Virology, Kiev). Dokl. Akad. Nauk SSSR; 186: 219-21(1 May 1969). (In Russian).

The influence of trypsin, histones, calf thymus, actinomycin D, and their combinations on biosynthesis of RNA in the liver of irradiated rats was studied. Tabulated data indicate a higher level of RNA synthesis in the liver nuclei of control animals than in irradiated animals. The tables also show that the content of unbroken DNA was 11% in control and 19% in irradiated rats. The specific radioactivity of RNA synthesized in irradiated animals after treatment with DNA was about 1.7 above the norm, revealing a direct relationship between active DNA and intensity of RNA synthesis. (R.V.J.)

16028 XANTHINE DEHYDROGENASE ACTIVITY IN PARENTAL AND F_1 DROSOPHILA AND HABROBRACON UNDER CONDITIONS OF HYPOGRAVITY. Keller, E. C. Jr. (West Virginia Univ., Morgantown). Bioscience; 20: 1045-9(1 Oct 1970).

Experiments were conducted to study effects of interacting flight (Biosatellite II) and γ irradiation factors on xanthine dehydrogenase activity in Drosophila and Habrobracon and their progeny. For each experiment there were four major groups: irradiated/flight, nonirradiated/flight, irradiated ground, and nonirradiated ground. Results of Drosophila experiments indicated that the difference between rate of response of enzyme levels was caused by the interacting nature of vibration, irradiation, and hypogravity. Results of Habrobracon experiments showed that there were decreased enzyme levels in all of the orbited groups as compared to their appropriate control groups, and as the radiation dose increased there was an increased enzyme differential of the xanthine dehydrogenase activity between the orbited and ground control groups. (H.L.W.)

XUM

16029 HORMONE-MEDIATED CHANGES OF LIVER POLYRIBOSOMES IN IRRADIATED RATS. Baeyens, W.; Goutier, R.; Vangheel, V. (CEEN, Mol, Belg. Univ., Liege). Strahlentherapie; 140: 204-12(Aug 1970).

Rat liver polyribosomes were isolated 24 h after whole-body irradiation with doses of 500 R to 2000 R of x-rays, and analyzed by centrifugation on sucrose density gradients. Irradiation produced an increase in the proportion of the heavier polysomes and enhanced the in vitro amino-acid incorporating capacity of polysome preparations. Local irradiation of the liver failed to modify the polysome pattern, whereas whole-body irradiation with shielded liver produced a shift in the polysomes. Injection of ACTH to normal rats altered the polysomes profile in the same way as x-irradiation. Irradiation of 9 day old rats with poor hypothalamus-pituitary connections had only very minor effects on the liver polysomes population. Bilateral adrenalectomy did not usually prevent the radiation-induced shift in polysomes: this fact proved to be linked to the presence of accessory adrenal tissues in the strain of rats used. The lack of extra-adrenal tissue in one animal allowed adrenalectomy to effectively prevent the alteration of liver polysomes after irradiation. It was concluded that the radiation-induced shift of the polysome pattern to a higher proportion of heavier polysomes appears to be, at least in part, a rather late result of the first stress reaction and occurs through stimulation of the hypothalamus-pituitary-adrenal axis. (auth)

16030 METABOLISM OF ISOLATED PERFUSED RAT LIVER FOLLOWING IN VITRO IRRADIATION. II. INTRA- AND EXTRACELLULAR CONTENT OF FREE AMINO ACIDS, TAURIN, AND UREA. Staehler, Fritz; Sinn, Ingolf (Univ., Hamburg). Strahlentherapie; 140: 213-20(Aug 1970). (In German).

Isolated rat liver is perfused and irradiated with x-rays (200 kV) at doses of 1000 or 5000 rd. In the next three hours, the amino-acid content of the cytoplasm and of the perfusion plasma is followed. The incorporation of tryptophan and arginine seems decreased, while the elimination of threonine is enhanced. The taurine-synthesis seems stimulated. The mean quotient of the intra- and extracellular content of all amino acid studied is decreasing with dose. The active transport perturbations are discussed. (auth)

16031 METABOLIC STUDIES OF THE NICOTINAMID COENZYME FOLLOWING WHOLE-BODY IRRADIATION. III. SYNTHESIS OF NAD AND ITS PRECURSORS IN ISOLATED PERFUSED LIVERS. Gerber, G. B.; Deroo, J. (CEN-SCK, Mol, Belg.). Strahlentherapie; 140: 231-5(Aug 1970). (In German).

Formation of NAD, its precursors as well as its catabolites, was investigated in perfused liver isolated from normal and x-irradiated rats (24 h after 1000 R). Tracer doses of labeled nicotinic acid were added as flash at the start of the perfusion, and samples from liver and perfusate were taken at short intervals up to 15 min. Nicotinic acid is rapidly taken up by the liver and converted to phosphorylated products. After irradiation, uptake of nicotinic acid by the liver is slightly accelerated, whereas conversion of NSAD to NAD is somewhat delayed. (auth)

16032 ACTIVITY OF ESTERASES IN RABBIT BLOOD AND ORGANS AFTER X-IRRADIATION. Levitskii, A. P.; Savitskii, I. V. (Medical Inst., Odessa). Ukr. Biokhim. Zh.; 40: 519-22 (1968). (In Ukrainian).

Activity of lipase, carboxylesterase, and arylesterase in homogenates of the liver, pancreas, and duodenum as well as in blood serum of rabbits under normal conditions and after total x irradiation with a dose of 400 R was studied. Arylesterase was found to be the most active. A 1.5- to two-fold increase was observed in the activity of all the esterases of the duodenum and pancreas six hrs after irradiation. The activity of liver and blood serum esterases did not differ from the norm. Twenty-four hrs after irradiation the activity of all the enzymes increased only in the duodenum, in the other organs the deviations of the enzyme activity level from the norm was not authentic statistically. A 2.5-fold increase in the activity of all the duodenum esterases, of pancreas lipase and bloom serum carboxylesterase and a 1.5-fold increase in the activity of the liver lipase were observed seven days after irradiation. (auth)

16033 NEW APPROACH TO THE CONTROL MECHANISMS IN TUMOR CELLS. Comorosan, S.; Vieru, S.; Sandru, D. (Fundeni Hospital, Bucharest). Eur. J. Cancer; 6: 393-400 (Oct 1970).

A new type of "perturbation" technique for the study of cellular control mechanisms is presented: when a substrate S of a particular $E_{(s)}$-enzyme is "perturbed" through a very gentle irradiation up to 10^4 erg/mm^2, and then tested in the corresponding enzymic reaction, dose-dependent oscillations in the activity of $E_{(s)}$-enzyme are recorded. In a series of reactions of the $A \xrightarrow{E} B$ type or in a series of branched reactions of the $P_2 \xrightarrow{E_2} S \xrightarrow{E_1} P_1$ type, the oscillations induced by the corresponding "perturbed" substrates in the activity of the respective enzymes were found to be non-overlapping. A typical biochemical "flip-flop" is thus obtained. The pyruvate ⇌ lactate, glutamate ⇌ α-oxoglutarate, and aldolase-FDPase "flip-flop" reactions realized with low level uv-irradiated substrates were investigated on Ehrlich-ascites tumor cells. Unexpected results were recorded. In the pyruvate ⇌ lactate reaction, the oscillations in the LDH activity could be induced only by uv-irradiated pyruvate, but not with uv-irradiated lactate. The accumulation of lactic acid by tumoral tissues may be analyzed in this context. Likewise, in the glutamate ⇌ α-oxoglutarate reaction, the oscillations in the GDH activity could be induced only by uv-irradiated glutamate, but not with uv-irradiated glutarate. In the aldolase-FDPase reaction, the oscillations were induced in the aldolase activity at very low-"perturbation" (i.e., irradiation) energies of fructose 1,6-diphosphate, providing a molecular model for the intense glycolytic flux of tumor tissues. The relevance of the new type of approach for the study of control mechanisms in tumor cells is discussed. (auth) (UK)

16034 INTERACTION BETWEEN TYROSINE AND DIVALENT SULFUR IN FLUORESCENCE QUENCHING AND IN THE PHOTOCHEMISTRY OF RIBONUCLEASE. Arian, Shulamit; Benjamini, Mira; Feitelson, Jehuda; Stein, Garbriel (Hebrew Univ., Jerusalem). Photochem. Photobiol.; 12: 481-7(Dec 1970).

Ribonuclease is inactivated in aqueous solution by uv light through different mechanisms according to whether divalent sulfur or aromatic amino acids are the primary light absorbers. At 284 nm, absorbed mainly by tyrosine, the presence of O_2 inhibits photoinactivation and H_2S formation, but does less so at 254 or 313 nm. Based on data with model substances containing disulfide groups a mechanism is indicated in which excited tyrosine is quenched through electron transfer to adjacent divalent sulfur within the protein. Disulfide compounds were found to be very efficient quenchers of tyrosine fluorescence. (auth) (UK)

16035 EFFECT OF SELECTIVE TUMOR HEATING ON THE LOCALIZATION OF ^{131}I-FIBRINOGEN IN THE WALKER CARCINOMA 256. 2. HEATING WITH MICROWAVES. Copeland, E. S.; Michaelson, S. M. (Univ. of Rochester, N. Y.). Acta Radiol., Ther., Phys., Biol.; 9: 323-36(Aug 1970).

Heating of Walker carcinoma 256 by selective irradiation with 2800 MHz, 0.258 watt/cm^2 microwaves for five min induced a substantial increase in the amount of intravenously injected ^{131}I-fibrinogen that will localize in the tumor. In irradiated tumors, radioactivity was widely distributed and seemed to coincide with histologically demonstrable areas of tumor damage. This tumor heating technique could potentially increase tumor radiation therapy dose from ^{131}I-fibrinogen 400%. (auth) (Sweden)

16036 CONDUCTIVITY INDUCED BY X RAYS IN DNA FILMS. Gaehwiler, B.; Zschokke-Graenacher, I.; Baldinger, E.; Luethy, H. (Univ., Basel). Phys. Med. Biol.; 15: 701-4(Oct 1970).

The x-ray induced conductivity in DNA films of 50 μm thickness was investigated. The current increases linearly with the exposure rate and, below the saturation value, also with voltage. The product of the mobility and the charge carrier lifetime was found to be approximately 10^{-7} cm^2/V. (auth) (UK)

16037 INACTIVATION OF TRYPSIN BY ULTRAVIOLET LIGHT AS A FUNCTION OF WAVELENGTH AND CONFORMATION. Ghiron, C. A.; Sellers, D. R. (Univ. of Missouri, Columbia). Photochem. Photobiol.; 12: 433-7(Nov 1970).

The quantum yield for uv inactivation of trypsin in various conformational states was determined as a function of wavelength. Heat and 8M urea were the methods used to modify the protein conformation during the period of illumination. Denatured hemoglobin and benzoyl-L-arginine ethyl ester (BAEE) were used as substrates. During the H6 assays, the quantum yield was temperature independent when 280 nm light was used, but with 250 nm light, the yield was temperature independent from 16 to 40°C and then it rapidly increased between 40 and 60°C. The yield at 60° was greater than at 16° at all wavelengths between 200 and 320 nm except 280 nm. The largest differences were at 250 nm and wavelengths greater than 300 nm. The quantum yield for uv inactivation of trypsin in the presence and absence of 8M urea at 16°C (pH 3) assayed by BAEE was plotted as a function of wavelength. The quantum yield for the perturbed protein was greater at all wavelengths from 240 to 315 nm except at 280 nm. At room temperature control solutions of 42 μM trypsin in 8M urea were stable. (UK)

16038 INCORPORATION OF ^{14}C- AND ^{3}H-THYMIDINE IN LYMPHOCYTES AFTER EXTRACORPOREAL IRRADIATION OF

THE BLOOD. Rosengren, B.; Bergentz, S. E.; Lindahl-Kiessling, K.; Lindholm, L.; Persson, B. (Univ. of Goteborg. Uppsala Univ.). Rev. Eur. Etud. Clin. Biol.; 15: 778-82(Aug-Sep 1970).

Incorporation of thymidine in lymphocytes after extracorporeal irradiation of blood (ECIB) was measured in blood samples collected before and after one or several exposures and taken at different intervals after a single exposure. A decrease in the incorporation after PHA stimulation was observed and comparisons were made between different irradiation series and with blood samples irradiated in vitro. It was concluded that ECIB causes a decrease in the incorporation of thymidine in the lymphocytes, particularly in samples taken immediately after irradiation. There were marked individual variations in the response, which may be due to variations in the exchange between circulating and non-circulating lymphocytes. A diminished response in one way mixed lymphocyte culture after ECIB was found to reflect the immunological response in a transplantation situation. (France)

16039 UPTAKE AND ELIMINATION OF BILIRUBIN BY THE LIVER IN RABBITS WITH OR WITHOUT EXPOSURE BY CESIUM GAMMA RAYS. Schmidt, M.; Souchon, F.; Kriegel, H.; Stich, W. Int. J. Radiat. Biol.; 18: 595-8(1970). (In German).

Single whole-body irradiations from 700 to 2800 R were used. Bilirubin in blood serum determined by spectrophotometry decreased as the sum of two exponentials, one for uptake with half-life 1 to 2 min in all cases, the other for elimination with half-life increasing from 18 ± 6.9 min (control) to 80 min (2800 R) with correlation +0.64. Comparison with human values indicated perturbation of liver bilirubin elimination to be likely at gamma doses 1400 to 2100 R. (UK)

16040 FORMATION OF FORMALDEHYDE IN IRRADIATED STARCH. Berger, Gerard; Saint-Lebe, Louis (CEA, Cadarache, France). Compt. Rend., Ser. D; 271: 552-5(3 Aug 1970). (In French).

Formaldehyde was observed in irradiated starch by colorimetry. The variations of its dose rate was studied as a function of the absorbed dose, storage time, and irradiation conditions. (auth) (France)

16041 PLASMA LIPOPROTEINS BIOSYNTHESIS IN THE RAT FOLLOWING X IRRADIATION. Raisonnier, A.; Infante, R.; Alcindor, G.; Petit, D.; (and others) (INSERM, Paris. CHU, Paris). Compt. Rend. Soc. Biol.; 164: 20-5(1970). (In French).

Changes in plasmatic lipids were studied in rats after sub-lethal irradiation. The importance of esterification processes at the level of the isolated perfused liver was estimated and the synthesis and secretion of plasmatic lipoproteins were measured. In the development of the irradiation syndrome, rats irradiated at sub-lethal doses, unlike animals exposed to a fatal dose, present a hypolypemia bearing essentially on the triglycerides. This hypolypemia seems to be due to a defect in the synthesis of very low density lipoproteins 26 hr after exposure to ionizing radiations. (France)

16042 STUDIES OF RADIATION CHEMISTRY AND BIOLOGY WITH THE IPCR 160 cm CYCLOTRON. Karasawa, T.; Seki, H.; Imamura, M.; Matsuyama, A.; Matsui, M. (Inst. of Physical and Chemical Research, Yamato, Japan). pp 76-87 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

A collimated beam (~5 mm diameter) emerged through a thin aluminium foil. Liquid samples were contained in a glass vessel. Part of the beam to be absorbed by the sample was elastically scattered by a thin metallic foil and monitored by a solid state detector. The "charge displacement" effect for both protons and He ions increased with the ionisation of the particles and with their range. Radiation effects in the liquid phase were strongly influenced by stirring and by beam intensity. Stirring was accomplished by a magnetic stirrer or by bubbling air through a capillary. $G(Fe^{3+})$ values were measured in the Fricke dosimeter for various values of L.E.T. For high intensity and high L.E.T., $G(Fe^{3+})$ is given by $G(Fe^{3+}) = \frac{3}{2} G(H_2O_2) + \frac{1}{2} G(OH)$. The incidental effect of beam intensity on radiation killing of bacterial cells due to non-uniform irradiation of the suspension was examined at a constant rate of air bubbling. The following equation is proposed to explain this effect for 26 MeV α-particles; $S = \exp\{(-It/q_0)[1 - \exp(-kq_0/I)]\}$ where S is the surviving fraction, q_0 is D_{37} in nanocoulombs, t is the irradiation time in s, I is the beam current in nA and k is a constant which depends upon the rate of aeration and the size of the effective volume. The values of D_{37} are reported for the various bacterial cells examined. (auth) (UK)

16043 IRRADIATION OF SIMPLE BIOLOGICAL SPECIMENS BY CHARGED PARTICLES. Neary, G. J. (Medical Research Council Radiobiological Research Unit, Harwell, Eng.). pp 194-203 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

In order to study basic mechanisms of the biological effects of charged particle irradiation the L.E.T. should be defined as closely as possible, since the effects depend on the quality of the radiation as well as on the dose. Consideration of stopping power data shows that the biological specimens must be of cellular dimensions and the minimum range of the particles ~50 μ. Furthermore, any particular value of L.E.T. requires the use of particles of some minimum mass and speed, and to cover the whole region of L.E.T. of biological interest a variety of particle types is needed. The use of a foil of heavy element to spread the beam by multiple scattering for ensuring satisfactory uniformity of dose over the specimen, the determination of dose by a small air-filled ionisation chamber, the monitoring of the beam by secondary emission from a thin foil in vacuo, and the method of containment of the specimens are described. Some examples of the findings in this type of radiobiological investigation are given, including strand breakage of DNA in vitro, cell killings and chromosome aberration production. Differences in the radiation quality dependence of cellular effects and effects on cellular components in vitro show that the repair mechanisms of cells probably act in a selective way on the various types of lesion initially produced in a cell, and the results show that L.E.T. alone is not a complete specification of radiation quality. (auth) (UK)

16044 SUNLIGHT-INDUCED PYRIMIDINE DIMERS IN HUMAN CELLS IN VITRO. Trosko, J. E.; Krause, D.; Isoun, M. (Michigan State Univ., East Lansing). Nature (London); 228: 358-9 (24 Oct 1970).

Pyrimidine dimers have been implicated in uv induced damage in bacteria and can also be induced in mammalian cells with short wavelength uv. The studies described indicated that normal exposure of human cells to natural sunlight can induce significant formation of pyrimidine dimers. The results were considered interesting in connection with the suggestion that uv-induced cancer might be explained by the somatic mutation theory; if mutations can cause cancer in humans, and if mutations are the result of defective repair of uv-induced pyrimidine dimers, as in bacteria, the present findings show there is a molecular basis for such an hypothesis. (UK)

16045 EFFECTS OF PARTIAL DEUTERATION ON THE PROPERTIES OF HUMAN HEMOGLOBIN. Tomita, Susumu; Riggs, Austen (Univ. of Texas, Austin). J. Biol. Chem.; 245: 3104-9(25 Jun 1970).

Oxygen binding by different subunits in human hemoglobin is greatly reduced by partial deuteration. The effect depends on the time of exposure: n in Hill's equation decreases from 2.8 to about 1.9 after the hemoglobin has been in D_2O for 20 hr at 4°. Further incubation results in a gradual return to normal values $n \cong 2.8$ after 240 hr. These effects could be explained if the rates of deuteration of certain parts of the α and β-chains differed. The normal alkaline Bohr effect is unchanged by deuteration. Molecules in which most of the exchangeable hydrogen was replaced with deuterium are more resistant to denaturation by heat and to autoxidation. (auth)

16046 LATE EFFECTS OF IONIZING RADIATIONS ON INORGANIC PYROPHOSPHATASE OF LIVER. Ghizari, Eugenia (Inst. of Normal and Pathological Physiology, Bucharest). Stud. Cercet. Fiziol.; 14: 247-54(1969). (In Rumanian).

The activity of the inorganic pyrophosphatase, at pH 5.3 and 7.4, of the liver of mice irradiated with different doses of x radiations from 25 to 1000 R was studied at time intervals from one to 12 days after the irradiation. It was established that the activity of the enzyme is inhibited both at pH 5.3 and pH 7.4 in the case of high doses (1000, 500, and 250 R), whereas the low doses (125, 50, and 25 R) do not modify the activity of this enzyme. (tr-auth)

16047 THE CHANGE IN THE AGAR-BINDING REACTION IN NEOPLASMS AND LEUKEMIAS AFTER ADMINISTRATION OF PENTOSANPOLYSULFOESTER. Szirmai, E. (Univ., Stuttgart); Sachs, V.; Stamm, H. Haematologica (Pavia), 53: 370-6(May 1968). (In German).

It was previously reported that cells of tumors in the blood of animals do not metastasize if the animals were treated with strep-

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tokinase or heparin. Investigations were carried out using pentosanpolysulfoester (SP 54) and the Agar fixation-reaction after Csaba-Törö on 39 genital carcinomas, 4 chronic myeloid and 1 chronic lymphatic leukemias, and finally with 9 healthy persons. It was found that heparin produced structurally and by metachromic phenomenon a positive Agar-fixation-reaction. The examinations with irradiated Agar (1200 R γ) produced similar effects. With addition of SP 54 only 19 positive results were found. It can be assumed that SP 54 has an anticancerous effect. For the elucidation of this problem other investigations in vitro and in vivo have been started. (auth)

16048 EFFECTS OF DISINTEGRATION OF INCORPORATED ^{3}H AND ^{32}P ON THE PHYSICAL AND BIOLOGICAL PROPERTIES OF DNA. Rosenthal, Peter N.; Fox, Maurice S. (Massachusetts Inst. of Tech., Cambridge). J. Mol. Biol.; 54: 441-63(28 Dec 1970).

Pneumococcal DNA was labeled with high specific activities of ^{32}P or tritium-labeled pyrimidines and stored at −30°C in a casein hydrolysate medium. The kinetics of inactivation of genetic markers on the labeled DNA was examined using a transformation assay. In addition, the kinetics of DNA strand scission were examined as a function of isotope disintegration. Strand scission was determined by sedimenting labeled DNA in neutral and alkaline sucrose density-gradients containing sedimentation reference markers. Sedimentation coefficients were converted to molecular weight using Studier's relationship. The efficiency of strand scission per disintegration was then calculated. Disintegration of ^{32}P caused single-strand breaks with unit efficiency and double-strand breaks with an efficiency of 5%. Tritium disintegration produced single-strand breaks with an efficiency of 30% and double-strand breaks with an efficiency less than 1%. The biological activity of pneumococcal transforming DNA labeled either with ^{32}P or tritium declined as a simple exponential function of the number of disintegrations of the incorporated isotope. Heterozygous DNA hybrids containing a radioisotope in only one strand were prepared by annealing radioactive DNA with DNA labeled with the heavy isotopes ^{2}H and ^{15}N. The hybrid molecules were fractionated on cesium chloride density gradients and the inactivation kinetics of genetic markers in the hybrid DNA were examined. The rates of inactivation of markers on the labeled strand were nearly equal to the rates observed with homozygous DNA labeled in both strands. From this result we conclude that single strands of transforming DNA constitute the predominant sensitive element inactivated by disintegration of the radioisotopes. Genetic markers on the unlabeled strand of a tritium containing hybrid are four to five times less sensitive than are markers on the labeled strand. Homozygous DNA duplexes containing ^{32}P in only one strand appear to have multicomponent inactivation kinetics. These observations lend further support to single-strand integration models and lead us to postulate that a single-strand break constitutes an inactivating event. (auth)

Immunology

Refer also to abstracts 16282, 16306, 16337, and 16366.

16049 RADIOIMMUNOASSAY OF OVINE FOLLICLE-STIMULATING HORMONE (FSH). Bailly du Bois, Madeleine; Kerdelhue, Bernard; Jutisz, Marian (College de France, Paris). Compt. Rend., Ser. D; 271: 1556-9(28 Oct 1970). (In French).

A radioimmunological method to determine ovine FSH was developed, using immune serums specific to this hormone obtained in guinea pigs. The curves of response to doses supplied by sheep FSH from different sources are parallel to one another, and good agreement is observed between these results and those obtained by a biological test. The specificity of the determination was studied; only TSH interferes slightly. (auth) (France)

16050 MODIFICATION OF AN INCOMPATIBLE GRAFT-VERSUS-HOST RELATIONSHIP BY ADMIXTURE OF GRAFTS WITH F_1 HAEMOPOIETIC CELLS. Barnes, C. A.; Ilbery, P. L. T. (Univ. of Sydney). Int. J. Radiat. Biol.; 18: 547-55 (1970).

When lethally-irradiated CBA.T6T6 mice were grafted with mixtures of C57BL and (C57BL × CBA.T6T6)F_1 cells of bone-marrow or foetal liver the incidence of secondary disease was considerably reduced as compared with mice receiving the incompatible C57BL cells only. Cytogenetic examination of bone-marrow, spleen, thymus and lymph node and identification of CFU in blood showed that F_1 cells were not eliminated as anticipated and that C57BL cells persisted in similar numbers, whether or not the host had secondary disease. The mechanism of avoidance of secondary disease in these experiments appears to be adaptation of the incompatible allogeneic graft, the host being carried through the periods of haemopoietic and immunological insufficiency by the F_1 cells. The findings constitute not only a therapeutic advance in a hitherto incompatible graft-versus-host relationship but also require reappraisal of the dominant role accorded to GVHR in secondary disease. (auth) (UK)

16051 STUDIES ON THE APPARENT SERIAL PASSAGE OF TRANSPLANTATION IMMUNITY IN TOLERANT MICE. Silvers, Willys K. (Univ. of Pennsylvania, Philadelphia). Transplantation; 10: 538-44(Dec 1970).

The capacity of immunologically competent cells from normal or specifically sensitized A strain mice to abolish tolerance of CBA skin homografts, when passaged from one tolerant A strain recipient to another, has been investigated. Although, as expected, cells from sensitized donors abolished tolerance significantly faster than did those from normal mice, neither originally normal nor sensitized cells were able to abolish tolerance in more than their initial and first-passage hosts. However, the number of passages through which these cells appeared to be active was greatly enhanced by prior sublethal irradiation of the tolerant recipients, a treatment which, by itself, had no adverse influence on the tolerated grafts. Following this procedure, cells passaged from one tolerant animal to another were able to terminate tolerance of CBA skin homografts serially through as many as 24 mice. While it seems apparent that the adjuvant effect of irradiation stems from the fact that it creates Lebensraum for the establishment and proliferation of the transferred population of competent cells, the origin of these cells (whether they are solely the descendants of cells of the original inoculum or are eventually derived from the previously tolerant host(s)) remains to be determined. (auth)

16052 PRECURSOR CELLS IN DENSITY FRACTIONS OF LYMPH NODE CELLS: RELATION TO ANTIBODY-PRODUCING CELLS. Moav, Neomi; Harris, T. N. (Children's Hospital, Philadelphia, Univ. of Pennsylvania, Philadelphia). J. Immunol.; 105: 1522-9(Dec 1970).

Spleen cells of mice were transferred intravenously into x-irradiated syngeneic recipients which were also injected with sheep red blood cells (SRBC). The dose of irradiation was sufficient to prevent active immunization by the SRBC injected. At intervals thereafter, spleens of recipients were teased and the cells plated in agar against SRBC, to determine relative numbers of precursor cells for this immunologic response which was transferred. (P.B.M.)

16053 EXPERIMENTAL HEMATOLOGY SOCIETY MEETING HELD IN BALTIMORE, MARYLAND, DECEMBER 3–4, 1969. Congdon, C. C. (ed.). Exp. Hematol.; No. 20, 1-81(1970). (CONF-691214).

Separate abstracts were prepared for three papers presented at the conference. Approximately forty additional papers were presented on bone marrow transplants, graft-versus-host reactions, and other aspects of experimental hematology. (H.L.W.)

For abstracts of individual papers see: 16018, 16334, and 16366.

16054 VIRUS RNA SYNTHESIS BY ULTRAVIOLET-IRRADIATED NEWCASTLE DISEASE VIRUS AND INTERFERON PRODUCTION. Gandh, S. S.; Burke, D. C.; Scholtissek, C. (Warwick Univ., Eng.). J. Gen. Virol.; 9: 97-9(Oct 1970).

Chick embryo cells were infected with uv-irradiated Newcastle Disease Virus and an attempt was made to find RNA synthesis in interferon producing cells, using a hybridization method. Less than 10% of the RNA synthesized in cells infected with virus irradiated for 15 sec (9.2×10^4 erg/cm^2) was hybridizable with virus RNA. When cells were infected with virus irradiated for 60 or 180 sec, no virus RNA could be detected at all, though the cells still produced interferon. Virus that was irradiated for 360 sec gave similar hybridization results, but failed to induce such interferon formation. Labeling was carried out using 50 μCi of ^{3}H-uridine. (UK)

16055 IMMUNOLOGICAL STATUS OF THE BONE MARROW CELLS OF SHEEP ERYTHROCYTE-TOLERANT RATS. McCullagh, P. J. (Australian National Univ., Canberra). Aust. J. Exp. Biol. Med. Sci.; 48: 537-50(Oct 1970).

No evidence was obtained for specific collaboration between cells derived from thymus and bone marrow in the immune response of rats to sheep erythrocytes. Bone marrow cells did not enhance the ability of thoracic duct lymphocytes to restore immune responsiveness to sheep erythrocytes in irradiated rats. In comparison with thoracic duct lymphocytes, thymus cells were most inefficient as an immunologically restorative inoculum in this situation, and bone marrow cells did not augment their perfor-

mance. Bone marrow cells augmented the restorative capacity of spleen cells from immunized, irradiated donors, regardless of whether these were injected previously with thymus or bone marrow cells. No evidence was forthcoming for the existence of a modified subpopulation of cells in the thoracic duct lymph of tolerant rats. (auth) (Australia)

16056 METHODS FOR THE STUDY OF IN VITRO IMMUNIZATION OF MOUSE SPLEEN CELLS. **Mishell, Robert I.; Dutton, Richard W.; Raidt, Donald J. (Scripps Clinic and Research Foundation, La Jolla, Calif.). pp 83-91 of Hemic Cells in Vitro. /Farnes, Patricia (ed.). Baltimore; Williams and Wilkins Co. (1969).**

From Symposium of the Tissue Culture Association, San Juan, Puerto Rico. See CONF-680635.

Characteristics of immunocompetent cells in the lymph nodes, spleen, and circulation of animals are reviewed and the relation of these cells to antigens is discussed. The importance of developing new methods for studying cellular aspects of immunity is emphasized. A comparison of in vitro with in vivo reaction shows a similarity in magnitude, kinetics, antigen specificity, dose response, and ability to inhibit immunogenicity with antiserum made against the immunogen. A method designated the hot pulse technique was developed for studying proliferation. Small amounts of high specific activity tritiated thymidine are added to cultures for definite periods. Cells synthesizing DNA incorporate lethal amounts of the label while resting cells are unaffected. Results of experiments indicated that plaque forming cells are derived from a rapidly proliferating precursor population and that proliferation continues throughout the response. Further techniques are described for cell separation, physical differentiation of precursor cells after immunization, and identification of sources of precursors of antibody-forming cells. (H.L.W.)

16057 TRANSFER OF ANTIBODY PRODUCTION WITH CELLS FROM BURSA OF FABRICIUS. **Gilmour, D. G.; Theis, G. A.; Thorbecke, G. J. (New York Univ., N. Y.). J. Exp. Med.; 132: 134-47(1 Jul 1970).**

F_1 hybrid chicks isogenic for the strong B histocompatibility locus and for most weak H-loci were x-irradiated on day 1 after hatching, injected intraperitoneally on day 2 with dispersed cells of bursa, spleen, or thymus from 4- or 10-wk-old F_1 hybrid donors, and immediately challenged by the same route with either Brucella abortus, sheep erythrocytes, or a mixture of both together. The agglutinin titers were measured in sera obtained 1 wk later. With 4-wk-old donors, a greater primary response to Brucella abortus was obtained after transfers of cells from bursa than from spleen, while thymus was much less effective. With 10-wk-old donors, the decreasing order of response was spleen, bursa, thymus. Only splenic cells were effective in transferring a response to sheep erythrocytes, at either donor age. In tests of synergism by cell mixtures from pairs of organs, the only positive finding was a modest augmentation of titer against sheep erythrocytes by bursa + spleen as compared with spleen alone. Bursal cells from 6- or 10-wk-old donors were effective in transferring a response to sheep erythrocytes when antigen injection was delayed until 5 days after cell transfer. Splenic cells from hormonally bursectomized donors were ineffective in transferring a primary response, even when the donors were injected with antigen 1 wk before transfer. Preimmunization of normal donors led to marked increases in the responses to Brucella abortus produced by transferred splenic or thymic cells. With bursal cells, an increased response was obtained only if the interval between preimmunization and transfer was 17 rather than 7 days. With the 17-day interval, both bursal and thymic cells could also transfer a response to sheep erythrocytes. The primary sera to Brucella abortus produced after transfers of bursal or splenic cells contained almost entirely 19S antibodies. A 7S component was found in all the secondary sera tested. (auth)

16058 TREATMENT OF CANINE GRAFT-VERSUS-HOST DISEASE WITH METHOTREXATE AND CYCLOPHOSPHAMIDE FOLLOWING BONE MARROW TRANSPLANTATION FROM HISTOINCOMPATIBLE DONORS. **Storb, R.; Graham, T. C.; Shiurba, R.; Thomas, E. D. (Univ. of Washington, Seattle, Public Health Service Hospital, Seattle). Transplantation; 10: 165-72(Aug 1970).**

The effectiveness of immunosuppressive therapy with methotrexate was compared to that with cyclophosphamide in preventing or delaying the lethal graft-versus-host disease in dogs following bone marrow transplantation from unrelated donors that were mismatched with their recipients by canine histocompatibility testing. Recipients were prepared for transplantation by 1200 R of whole-body irradiation followed by combined infusions of donor marrow and peripheral blood leukocytes. Immunosuppressive drugs were administered on days 1, 3, 6, and 11 posttransplantation and once weekly thereafter until day 102. Four of six recipients in group 1 given 0.5 mg methotrexate/kg died between days 20 and 33 with acute graft-versus-host disease. One died on day 76 with penumonia, and one is alive more than 124 days posttransplantation. All eight recipients in group 2 given 5 mg cyclophosphamide/kg died between 11 and 20 days with graft-versus-host disease. Four of six dogs in group 3 treated with 7.5 mg cyclophosphamide/kg died with graft-versus-host disease between days 11 and 13. Two of the six failed to show evidence of marrow repopulation and died on day 13 with pneumonia. Three of four dogs in group 4 given 10 mg cyclophosphamide/kg died with marrow aplasia between days 8 and 10. One of the four died on day 20 with graft-versus-host disease. Statistical analysis of the survival data demonstrated the superiority of the methotrexate regimen ($P < 0.01$). (auth)

16059 BONE MARROW TRANSPLANTATION. AGGRAVATING FACTORS IN GRAFT-VERSUS-HOST DISEASE. **Hong, Richard; Bach, Fritz H. (Univ. of Wisconsin, Madison). Transplantation; 10: 192-4(Aug 1970).**

Five cases are cited involving bone marrow transplantation between histocompatibility-matched donor-recipient pairs in which the recipients had leukemia. The cases are of interest because all five resulted in a fatal outcome. Graft-versus-host (GVH) disease was implicated clinically as an aggravating or possibly determining factor in the transplantation failures. The following reasons were suggested for the failures: incompatibility between transplant-stimulated host marrow and the antigens contained in the cellular blood products received by the host during supportive therapy; incompatibility between the tumor-stimulated antigens present in normal host tissues and the antigens of the donor cells; an additive or even synergistic effect on the normally expected mild GVH reaction as a result of pretreatment of the recipient (before transplantation) with x rays and/or cyclophosphamide; or the additive effects of assorted minor loci incompatibilities in the presence of a major (tumor-stimulated antigen) incompatibility resulting in a fatal GVH reaction. It is noted that the above conditions are peculiar to cases involving malignancies. (E.R.B.)

16060 INCREASE OF THE SENSITIVITY OF ALBINO MICE TO THE VIRUS OF SMALLPOX AFTER TOTAL X-RAY IRRADIATION. **Marennikova, S. S.; Shafikova, R. A. (Scientific Research Inst. of Viral Preparations, Moscow). Byull. Eksp. Biol. Med.; 70: No. 8, 102-5(Aug 1970). (In Russian).**

Demonstrated is the possibility of inducing smallpox infection in adult albino mice (28 to 37 days old) in intracerebral infection with the aid of preliminary whole-body irradiation with gamma-rays in a dose of 400 R, this increasing by 2 to $2\frac{1}{2}$ times the period of natural sensitivity to the virus. The developing infection is characterized by propagation of the virus in the brain, lungs, kidneys, primary and secondary viremia; the clinical picture is similar with that in nonirradiated mice of the same age. An increase of the sensitivity of adult mice to intracerebral infection after irradiation is possible only up to a definite limit: 34 to 37-day-old mice are less sensitive than 28 to 31-day-old mice; 40 to 45-day-old mice do not react at all to the administration of the virus. The sensitivity after irradiation to intranasal and intravenous introduction of the virus could not be increased; this apparently could be explained by the augmented age of the animals. (auth)

16061 RADIATION EXPOSURE AND AGING IMMUNITY. I. **Kurusu, Akira (National Inst. of Radiological Sciences, Chiba, Japan). Hoshasen Kagaku; 13: 245-9(Mar 1970). (In Japanese).**

Effects of aging and radiation exposure on immune reactions are reviewed; specific abnormalities in immune responses as well as normal mechanisms are surveyed. Four phases of immune reactions are described. During the first, or afferent phase, the antigen is incorporated into macrophages. The second phase is the recognition phase in which antigen-sensitive lymphocytes gather antigen information and promote mass formation of antibody-producing cells. The first two phases require four to 24 hours. The third phase is the stimulatory period in which the appearance of immunoblasts is accompanied by a rapid increase in antibody-producing units. The last phase is the efferent phase in which the small lymphocytes and antibody-producing cells are hypersensitive to each other. The ability to discriminate between self and non-self antigens in living organisms and tolerance towards auto-antibody production are discussed. Relationships between loss of immune tolerance and autoimmune diseases in man are discussed. Damage to cells and tissues resulting from abnormal immune processes is reviewed. (Japan)

16062 EXPERIMENT IN PASSIVE TRANSMISSION OF HELIOTRINE LIVER DISEASE IN RATS BY LIVE SPLEEN CELLS.

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Levin, G. S. Patol. Fiziol. Eksp. Ter.; 13: 39-42(Mar-Apr 1969). (In Russian).

A suspension of splenic cells obtained from 38 rats with heliotrine cirrhosis of the liver was injected intravenously in 28 irradiated rats. Two controls consisted of 23 rats given splenic cells from healthy rats, and 28 irradiated rats. Perivascular lymphoidocellular infiltration took place in 14 of 28 rats in the experimental series, proliferation of bile epithelium in three and central necrosis in one. Cellular infiltration was also noted in 5 of 51 rats of the two control series. The efficacy of the transfer depended on the number of transferred cells, the severity and the activity of the process in the donor. The data obtained pointed to a possible participation of hypersensitivity of delayed type in the pathogenesis of heliotrine affections of the liver. (auth)

Ecology

Refer also to abstracts 15776, 15802, 15998, 16010, 16114, 16127, 16129, 16131, 16133, 16138, 16139, 16163, 16185, 16187, 16373, 16374, 18048, and 18225.

16063 (AEC-tr-7214, pp 1-8) BODY BURDENS OF ^{137}Cs IN VARIOUS GROUPS OF NATIVE POPULATIONS OF THE NENETS NATIONAL DISTRICT IN 1965. Moiseev, A. A. Translation of A-AC-82/G/L-1188.

From USSR reports on radioactivity in man and the environment.

The content of ^{137}Cs in the native population of the Nenets National District in the winter of 1964-1965 and in the autumn of 1965 was measured with a simplified whole-body counter (a single channel gamma ray spectrometer weighing 14.2 kg). Statistically significant differences in ^{137}Cs burden were observed for men, women, and children. Mean values were related as 1.0 : 0.5 and 0.15 to 0.25. The highest ^{137}Cs burdens were observed in reindeer herdsmen. The mean value for a group investigated in September, 1965 was 8.7 ± 0.7 nCi/kg with a range of 3.8 to 12.0 nCi/kg body weight (190 to 800 nCi/whole body). The lowest levels were found in fishermen, with a mean of 1.0 ± 0.2 nCi/kg body weight and a range of <0.2-2.3 nCi/kg body weight. No statistically significant difference was found in levels of ^{137}Cs in men (not reindeer herdsmen) living in various localities. A statistically significant difference was found between levels of ^{137}Cs in children who spent the summer of 1965 in the town of Naryan-Marr (1.5 / 0.1 nCi/kg body weight) and those who spent their summer holidays (3 months) in the Continental tundra (5.0 ± 0.2 nCi/kg body weight). (auth)

16064 (AEC-tr-7214, pp 37-50) DIETARY INTAKE OF ^{90}Sr AND ^{137}Cs BY THE POPULATION OF THE SOVIET UNION FROM GLOBAL FALLOUT IN 1965 TO 1966. Knishnikov, V. A.; Petukhova, E. V.; Stepanov, Yu. S.; Barchudarov, R. M. Translation of A-AC-82/G/L-1186a.

From USSR reports on radioactivity in man and the environment.

The highest contamination levels of food products were observed over the country in 1963 and 1964. In 1966, ^{90}Sr and ^{137}Cs concentrations in the principal food products decreased in the country by an average factor of 1.5 to 2.5 times as compared with 1963 and 1964. The concentration of some food products as isotope suppliers in the Soviet Union differs from that in the USA and Western Europe. In the USSR ^{90}Sr and ^{137}Cs are taken in by the population mainly with bread and breadstuffs. Intake levels of these isotopes in the rural population of some Union republics differ by 1.5 to 2 times while differences in the urban population are less noticeable. The intake of ^{90}Sr with water was not more than 5% of its intake with food products. (auth)

16065 (AEC-tr-7214, pp 70-81) RADIOACTIVITY OF THE ATMOSPHERE AND CERTAIN FOOD PRODUCTS IN MOSCOW IN 1965 AND 1966. Zykova, A. S.; Telushkina, E. L.; Efremova, G. P.; (and others). Translation of A-AC-82/G/L-1192.

From USSR reports on radioactivity in man and the environment.

Data on radioactivity in air, milk, vegetables, and fallout collected over two years (1965 and 1966) are given. A further decrease of β activity in fallout and in the atmosphere was observed in 1965 and 1966 as compared with preceding years. The radioactive aerosols mostly contained ^{106}Ru + ^{106}Rh and ^{144}Ce + ^{144}Pr. The quantity of ^{137}Cs and ^{90}Sr, expressed in absolute terms decreases each year, their relative contribution to the total β activity being enhanced. The fact that ^{137}Cs and ^{90}Sr concentrations in milk were not significantly lower in 1965 and in 1966 than in 1964 gives evidence that soil contamination with these isotopes is a principle source of their content in milk. The ratio of ^{137}Cs to ^{90}Sr in fallout and in the air was also studied. Considering the results obtained in the study one may suppose that elimination of the aerosols containing ^{137}Cs from the troposphere takes a more rapid course than that of aerosols containing ^{90}Sr. (auth)

16066 (AEC-tr-7214, pp 87-107) RADIOACTIVITY IN MODERN MAN. Pertsov, L. A.; Popov, D. K.; Dzyubenko, I. I.; (and others). Translation of A-AC-82/G/L-1182.

From USSR reports on radioactivity in man and the environment.

Defining the concentration of potassium in 100 dead bodies of different ages, a close dependence was found between the level of potassium and age, from 1.4 ± 0.3 g/kg in a new-born child's body to 2.6 ± 1.7 g/kg in adults 21 to 30 years old. The determination of ^{40}K specific activity gives a similar regularity, from 1.12 ± 0.24 nCi/kg in a new-born child's body to 2.08 ± 0.14 nCi/kg in adults 21 to 40 years old. There was no significant difference between males and females. The investigation of natural ^{40}K burden in different organs and tissues of the body showed irregularity. The inhabitants of seven different regions of the U.S.S.R. are characterized by different potassium concentrations: from 1.0 ± 0.3 g/kg to 2.5 ± 0.2 g/kg, and total β activity from 0.8 ± 0.24 nCi/kg to 2.0 ± 0.16 nCi/kg. That was found in 183 investigated specimens. The ^{226}Ra and ^{228}Th concentrations (in pCi/kg) in the skeleton of the inhabitants (139 investigated specimens) of 17 regions showed well defined fluctuations also. This can be also applied to the content of ^{210}Po (in pCi/kg) in the hair of the inhabitants of 32 regions. These fluctuations were considerable, reaching a factor of four or five. (auth)

16067 (AEC-tr-7214, pp 108-14) ^{90}Sr AND ^{210}Po IN THE BONES OF INHABITANTS OF THE FAR NORTH IN 1965. Litver, B. Ya.; Moiseev, A. A.; Ramsaev, P. V. Translation of A-AC-82/G/L-1190.

From USSR reports on radioactivity in man and the environment.

Results are given for bone samples (rib, sternum) taken from 27 subjects aged from 15 to 73 who lived for a long time in the Nenets National District (North of 68°) and died in 1965. Strontium-90 concentrations in the bones had a wide range of variability from 2.6 pCi/g Ca to 26.8 pCi/g Ca. Average concentrations of ^{90}Sr in the bones of inhabitants of the far north were four to six times higher than in the inhabitants of the central areas. Tissue doses to the red bone marrow were from 2.4 to 24.2 mrad/year. Mean concentration of ^{210}Po in the bones of reindeer breeders were 117 ± 21 pCi/kg of raw bone. The maximum concentration was 270 pCi/kg of bone. In the bones of people whose diet did not contain reindeer meat, the mean concentration values of ^{210}Po were 2.4 times lower than in the reindeer breeders. It is shown that the correlation coefficient between concentrations of ^{90}Sr and ^{210}Po in the bones of inhabitants in the far north is equal to 0.21 ± 0.29. It may be concluded that these two radionuclides enter the human body through different food chains. (auth)

16068 (AEC-tr-7214, pp 115-25) ^{90}Sr IN THE BONE TISSUE OF THE POPULATION OF THE SOVIET UNION. Marei, A. N.; Borisov, B. K. Translation of A-AC-82/G/L-1184.

From USSR reports on radioactivity in man and the environment.

During the last three years, the age distribution of ^{90}Sr in human bone has changed. Specifically, along with a decrease of bone, specific activity in younger children, an annual shift of maximal values towards the older age is observed. Within the country ^{90}Sr concentrations in the same age groups of the population are not single-valued. Data of 1965 and 1966 mostly confirm the previously determined geographical dependence of ^{90}Sr concentrations in bone of the population in different areas of the country. The highest average values are observed in northern areas of the European part and in the Transcaucasus. The lowest are found in the Ukraine. (auth)

16069 (AEC-tr-7214, pp 126-42) CONTENT OF ^{137}Cs AND POTASSIUM IN THE POPULATION OF THE USSR IN 1962 TO 1966. Belle, Yu. S.; Krisyuk, E. M.; Lebedev, O. V.; Shamov, V. P.; Shapiro, E. L. Translation of A-AC-82/G/L-1193.

From USSR reports on radioactivity in man and the environment.

Results obtained from measuring the concentrations of ^{137}Cs incorporated in the body of 1022 individuals in the Soviet Union are presented. The study was made in 1962 to 1966 with a liquid scintillation counter and a scintillation spectrometer. The average age of the subjects was 33 years. The maximal body burden of ^{137}Cs was found in 1964: 28.7 ± 0.7 nCi in men and 17.3 ± 0.5 nCi in women. In the first half of 1966, the mean values of ^{137}Cs were: for men 14.7 ± 0.5 nCi, and for women 7.6 ± 0.5 nCi. Data on the biological half-life of ^{137}Cs for men and for women are also given. Mean values were about 80 days for women and 105 days for men. Dependence of ^{137}Cs body burden on age and sex of the subjects was also determined. It is shown that potassium distribution in the uniform group of men is described by a normal law and the ^{137}Cs distribution was lognormal. (auth)

16070 (AEC-tr-7214, pp 249-66) FALLOUT OF ^{90}Sr ON THE TERRITORY OF THE UKRAINIAN SSR IN 1963 TO 1966. Muchin, I. E.; Nagovitsina, L. I. Translation of A-AC-82/G/L-1199.

From USSR reports on radioactivity in man and the environment.

The results of four years of observations of the ^{90}Sr fallout and the degree of uptake by biological sections of the food chain are presented. In the Ukraine, the density of ^{90}Sr fallout always followed the total yearly precipitation during all years of observation. The linear dependence between the ^{90}Sr fallout and the accumulation of this radioisotope in milk is established. The contribution of the accumulated ^{90}Sr in foodstuffs increased greatly during the last year and is equal to more than 50% of the total content of radioisotopes in foodstuffs. The ^{90}Sr content in the diet of all age groups of the Ukrainian population decreased considerably during the last years. The basic contribution of the ^{90}Sr in the diet is related to the consumption of bread and foodstuffs from food crops. The accumulation of radiostrontium in the bone tissue of the population has an asymmetric character. The concentration of ^{90}Sr in the adult bone averages 1.4 strontium units. (auth)

16071 (AED-C-2-10) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 02: CONTAMINATION AND DECONTAMINATION OF FOOD. Beising, K. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Apr 1970. 61p. Dep. NTIS (U. S. Sales Only).

Approximately 385 references are presented to publications that discuss mechanisms involved in the uptake of fallout radioisotopes by food and methods for the removal of radioactive contaminants from food. Abstracts of most of the references appeared in NSA Vols. 17 through 22. (C.H.)

16072 (BMI-171-110) RADIONUCLIDE AND STABLE ELEMENT ANALYSES OF ENVIRONMENTAL SAMPLES FROM AMCHITKA ISLAND, ALASKA. Annual Progress Report. Vogt, J. R.; Howes, J. E.; Ewing, R. A. (Battelle Memorial Inst., Columbus, Ohio). Nov 1968. Contract AT(26-1)-171. 50p. Dep. NTIS.

An effort to conduct radionuclide and stable element analyses of environmental samples from Amchitka Island, Alaska was initiated by Battelle–Columbus in order to provide stable element concentrations for use with a specific activity model for calculating the potential internal radiation dose to man, and to provide pre- and post-shot data on radionuclide burdens in the Amchitka Island environment. During FY 68, 230 samples were collected by subcontractors and Battelle for possible radionuclide and stable element analysis. While many of these samples were prepared for analysis, only a few were analyzed prior to the end of FY 68. Inventories of collected and prepared samples as well as the results of those radionuclide and stable element analyses which were completed are included. Analytical procedures are given in the appendix. Inventory data are included for freshwater fish and plankton, marine invertebrates, fish, birds, algae, lichens, and soil samples. Tables are presented to show contents of ^{137}Cs, ^{40}K, and ^{90}Sr in marine crustaceans, algae, fish, birds, and sea otters. Stable element concentrations are tabulated for perch, king crabs, zooplankton, emperor goose, mud, and stream water. (auth)

16073 (BMI-171-113) RADIOMETRIC AND ELEMENTAL ANALYSES ON MARINE ORGANISMS FROM AMCHITKA, ALASKA. Annual Progress Report, July 1, 1967–June 30, 1968. Isakson, John S.; Seymour, Allyn H. (Washington Univ., Seattle. Fisheries Research Inst.). 26 Sep 1968. Contract AT(26-1)-171. 27p. Dep. NTIS.

For Battelle Memorial Inst., Columbus, Ohio.

Existing levels of radionuclide and stable elements in organisms considered important in the marine fauna and flora of Amchitka were established. Counting facilities of the Laboratory of Radiation Ecology were used. Stable elements were measured by semiquantitative spectrographic analysis. Specific activities for K, Co, and Mn were computed where possible. The marine organisms contain low but possibly seasonally variable levels of radionuclides. Increase in levels from August–September, 1967 to February–March, 1968 was noted. Differences among tissues were documented. No levels of fallout radionuclides exceeded the present ^{40}K levels at Amchitka. It is recommended that analytical work for the purpose of providing accurate baselines of existing radionuclide levels precede each nuclear test. An increase in radionuclide levels seen at a postevent date could not be fully explained without immediate pre-event information. Seasonal monitoring of a few selected organisms, possibly coordinated with the known atmospheric testing of other nations, could provide guidelines as to the contribution of such tests to the Amchitak environment. Tables are presented to show the gamma spectrum analysis of fish for ^{40}K, ^{60}Co, ^{54}Mn, and ^{137}Cs. Data are also tabulated for analyses of marine invertebrates for ^{40}K, ^{60}Co, ^{54}Mn, ^{106}Ru, and ^{144}Ce for analyses of marine algae for ^{40}K, ^{60}Co, ^{54}Mn, ^{137}Cs, and ^{106}Ru. (auth)

16074 (BMI-171-118) SIMULATION STUDIES AS RELATED TO THE ECOLOGICAL EFFECTS OF UNDERGROUND TESTING OF NUCLEAR DEVICES ON AMCHITKA ISLAND. Annual Progress Report. Raines, G. E.; Bloom, S. G. (Battelle Memorial Inst., Columbus, Ohio). Feb 1969. Contract AT(26-1)-171. 50p. Dep. NTIS.

During the past year, simulation studies were concerned with sea otter population dynamics, statistical implications of transplanting small colonies of sea otters, physical transport of radionuclides in the marine environment, and mathematical methods for evaluating the transport and accumulation of radionuclides. A preliminary model of sea otter population dynamics was derived and explored. The model considered only the interactions of the otter with its food and predicted values for the peak otter population and the time to reach the peak that were in good agreement with published information on population trends since 1910. The model was then used to estimate the effects on the equilibrium population due to sudden changes in the sea otter population and in its food supply. The results suggest, except for changes in the rate of food production (e.g., via habitat damage), the otter population rapidly returns to the equilibrium value. This effort was intended to demonstrate feasibility of modeling population dynamics. A more refined model must be developed for realistic evaluation. A simple birth-death model for the sea otter population was used to predict the probability of ultimate extinction of a transplanted colony and to predict the confidence in the estimate of the mean population. The probability of extinction ranged from a low of 1.9×10^{-48} for an initial colony of 100 to a high of 0.004 for an initial colony of 5. However, an initial colony of 10 will only have a mean population of about 74 after 20 years and with 95 percent confidence that the population will not exceed 135 nor be less than 12. The 95 percent confidence band decreases with increasing size of the initial colony and is about ±25 percent of the mean value for an initial colony of 100 after 20 years. These studies tend to show that transplants of colonies of 10 will probably not flourish, colonies of 30 may be practicable, and colonies of 100 may be necessary to achieve a significant population. A model for the physical transport of fallout radionuclides in the marine environment was derived. This model is based on an instantaneous, point source solution to a simplified partial differential equation for dispersion. On the assumption that this solution can be taken as a fundamental solution, the model was derived by integrating the point source expression over a fallout pattern. The expression for a constant fallout concentration over a rectangular pattern was obtained explicitly and, based on this expression, a simplified expression for the maximum concentration was derived. This latter expression can serve as a conservatively high estimate for the actual concentration. The mathematical methods to be used for evaluating the transport and accumulation of radionuclides were explained. The system of differential equations for describing the biological transport was derived and methods for obtaining the transfer coefficients were explained. Analytical, finite-difference, and semi-analytical methods for solving the differential equations were explained. The analytical methods included the use of the Laplace transform technique to obtain direct expressions for the infinite radiation dose from internally deposited radionuclides. (auth)

16075 (BNWL-1505(App.)) EVALUATION OF RADIOLOGICAL CONDITIONS IN THE VICINITY OF HANFORD FOR 1969 APPENDICES. Wilson, C. B. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1970. Contract AT(45-1)-1830. 120p. Dep. NTIS.

Results obtained from both radiochemical analysis of environmental samples and radiological measurements made in the Hanford environs during 1969 are tabulated. The data are discussed in BNWL-1505, which was abstracted previously for NSA. (C.H.)

16076 (FOA-4-4445) TRANSFER OF RADIOSTRONTIUM FROM PASTURE TO MILK. Auraldsson, H-A.; Eriksson, A.; Greitz, U. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Nov 1970. 18p. Dep. NTIS (U. S. Sales Only).

The transfer of radiostrontium from pasture to milk was studied in field experiments performed in 1968 and 1969. ^{85}Sr in water solution was sprayed onto the surface of a fenced pasture. Ten cows were brought there for a three days grazing period and then onto uncontaminated pasture. The concentration of ^{85}Sr in the milk and the milk production from each cow was measured twice a day. The experiment was performed three times in an essentially identical way. It was found that the concentration in milk following an initial deposition of 1 $\mu Ci/m^2$ on grassland amounted to about 0.03 $\mu Ci/l$. It was attempted to assess the fraction of deposited ^{85}Sr retained on the edible herbage consumed by the cows. The cows were given an oral single dose to establish the relation between intake and milk content. From this relation the intake per cow when grazing on contaminated pasture could be calculated. It was

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found that the fraction of ^{85}Sr which was retained on the edible herbage consumed by the cows was on the average 40 percent. This percentage corresponds fairly well to the retention factor found for world wide fallout particles. (auth) (Sweden)

16077 (MLM–1784) ENVIRONMENTAL MONITORING REPORT: JANUARY–JUNE 1970. (Mound Lab., Miamisburg, Ohio). 25 Jan 1971. Contract AT(33-1)-Gen-53. 36p. Dep. NTIS

The average concentrations of ^{210}Po, ^{238}Pu, and tritium detected in the environment surrounding Mound Laboratory, Miamisburg, Ohio, are presented for the first half of 1970. The average concentrations of these radioisotopes in the Great Miami River and at the air sampling stations were well within the stringent standards adopted by the Atomic Energy Commission. (auth)

16078 (NRL-F-39) ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND AND RESULTS OF EXTENDED MONITORING OF FALLOUT FROM FRENCH NUCLEAR TESTS IN THE PACIFIC FOR SAMPLES PROCESSED UP TO 27 JULY. Quarterly Report, January–March 1970. (National Radiation Lab., Christchurch (New Zealand)). 30p. Dep. NTIS (U. S. Sales Only).

Results of routine monitoring of total β activity from fallout in New Zealand during the first quarter of 1970 are reported. Country-wide averages are given for ^{90}Sr in rain, and ^{137}Cs and ^{90}Sr in milk. Extended monitoring of fallout for γ radiation from French nuclear tests in the Pacific was carried out. Daily air filter samples and weekly rainwater collections were measured for total β activity. The pattern of increase in activity during 1970 was similar to that observed during 1966, 1967, and 1968 series of nuclear tests. Results are reported for ^{131}I levels in milk and cattle thyroids. Results are presented in the form of tables and graphs. (H.L.W.)

16079 (NVO–79, pp 49-71) BIOLOGICAL EFFECTS. (Nevada Operations Office (AEC), Las Vegas).

From Physical and biological effects: Milrow Event.

The principal ecological effects of the AEC's use of Amchitka since 1966 have been those associated with site preparation and other operational activities. Test time studies show that the immediate effects of the detonation of the Milrow Event underground nuclear explosion are small in comparison. Since there was no release of radioactivity there were no effects of radioactivity at all. All effects seen were caused by ground and water shock. These are summarized. (C.H.)

16080 (RISO–222) ENVIRONMENTAL RADIOACTIVITY IN GREENLAND IN 1969. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe, Research Establishment). Jul 1970. 19p. Dep. NTIS (U. S. Sales Only).

Measurements of fall-out radioactivity in Greenland in 1969 are reported. Strontium-90 (and ^{137}Cs in most instances) was determined in samples of precipitation, sea water, vegetation, animals, and drinking water. Estimates of the mean contents of ^{90}Sr and ^{137}Cs in the human diet in Greenland in 1969 are given. (auth) (Denmark)

16081 LEVELS OF STABLE Zn AND ^{65}Zn IN CRASSOSTREA VIRGINICA FROM NORTH CAROLINA. Wolfe, D. A. (Bureau of Commercial Fisheries, Beaufort, N. C.). J. Fish. Res. Board Can.; 27: 47-57(Jan 1970).

The concentration of zinc in oysters was highly variable—samples from relatively unpolluted estuaries of North Carolina contained, on the average, 85 to 245 ppm zinc, based on wet weight. Internal tissues, like adductor muscle and pericardial sac, had zinc levels less than half those of external tissues but zinc was nonetheless distributed uniformly throughout the animal tissues. During 1964 to 66, North Carolina oysters contained 2 to 20 pCi ^{65}Zn from fallout per 100 g wet weight. Specific activity of ^{65}Zn in these oysters during 1965 to 66 was in the range 90 to 300 pCi/g Zn, and was declining with an apparent half-life of 276 days. (auth) (Canada)

16082 KINETICS OF ENVIRONMENTAL RADIOIODINE TRANSPORT THROUGH THE MILK-FOOD CHAIN. Pelletier, C. A.; Zimbrick, J. D. (Atomic Energy Commission, Idaho Falls, Idaho). pp 257-67 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

A program known as CERT (Controlled Environmental Radioiodine Tests) is being conducted at the National Reactor Testing Station in Idaho. The overall goal of the program is to obtain quantitative information on the kinetics of radioiodine transport from its point of release through the entire air-grass-cow-milk-human-food chain. The experiments are carried out under conditions that simulate as closely as possible the actual dairy farm environment adjacent to the NRTS site. The major results of the CERT research obtained thus far are summarized. These include deposition measurements, radioiodine transfer from grass to milk, and radioiodine transfer from milk and air to human thyroids. (E.E.H.)

16083 MATHEMATICAL MODEL FOR THE TRANSPORT OF RADIONUCLIDES IN STREAM SYSTEM. Shih, C. S.; Gloyna, E. F. pp 320-41 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

This paper presents a mathematical model which defines the distribution and transport of radionuclides in a stream. The detention of radionuclides resulting from chemical and biological activity is incorporated in the formulation. Continuous release experiments using ^{85}Sr in a model river were conducted to evaluate pertinent parameters used to define the magnitude of the detention. Also, an instantaneous release of ^{85}Sr in the same model river was made to test the proposed model. Predictions, based on the sorption–desorption model, were found to be fairly comparable with the experimental data derived from the model river studies. (E.E.H.)

16084 NATURAL DIFFERENCES IN CONCENTRATIONS OF ^{90}Sr IN MILK. Barber, D. E. (Univ. of Minnesota, Minneapolis). pp 368-81 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

The fact that four milksheds show high concentrations of ^{90}Sr and four milksheds show low concentrations of ^{90}Sr makes Minnesota unique among the states that have reported their data in Radiological Health Data and Reports since 1962. This feature permits differences in concentrations to be examined as a function of differences in environment over a geographic area many times that of a single milkshed without introducing variations caused by different sampling and analytical techniques. The procedures used and the results of such an examination are given. The data are discussed in relation to fallout depositions, cattle forage, land fertilization, soil chemistry, temperature and moisture, and organic matter. (E.E.H.)

16085 FATE OF ^{90}Sr IN SOIL, PLANTS, AND WATER. Haghiri, F. (Ohio Agricultural Research and Development Center, Wooster). Ohio Rep.; 55: 74-7(Jul-Aug 1970).

The amount of ^{90}Sr removed by runoff water, runoff sediment, leachate water, and plant materials from treated microplots under various management practices for the period of June 1962 to May 1967 are summarized. High rates of lime retarded downward movement of ^{90}Sr by crops and removal by leachate water. Crops, in general, reduced the loss of ^{90}Sr in runoff and leachate water. Sod crops were more effective in minimizing the strontium loss in runoff and drainage water compared with cultivated crops. The quantities of strontium taken up by the various crops differed and such differences among species roughly paralleled their adsorption of calcium. With the exception of corn crops from continuous corn plots, significantly more ^{90}Sr was removed by crops from rotation high lime and permanent grass plots than from their corresponding runoff water, sediment, and leachate combined. Under rotation low lime, the quantities of ^{90}Sr removed by crops were of about the same magnitude as by other processes. Over a 5-year period the total amount of ^{90}Sr loss by various processes was highest under gravel mulch and least under permanent grass system. The data from the field microplots indicate that the ecology of ^{90}Sr in Canfield silt loam soil is greatly influenced by soil and crop management practices. (C.H.)

16086 JOINT FAO/WHO EXPERT COMMITTEE ON MILK HYGIENE, THIRD REPORT, GENEVA, 22–28 APRIL 1969. World Health Organ., Tech. Rep. Ser.; No. 453, 1-84(1970).

The special problems involved in the production and distribution of milk in countries with hot climates are considered, following which the organization and administration of milk hygiene control programs are discussed. Following a consideration of the general problem of hygiene in milk production, collection, and transport, special attention is given to the standards of hygiene that should be observed in the handling and processing of milk in the dairy and in the distribution of pasteurized milk. The production of sterilized liquid milk is discussed with detailed attention given to the problems that are involved and the precautions that must be taken. Similar attention is given to the production of milk products, such as cheese, butter, ghee, ice cream, cream, fermented milk, flavored milk, evaporated and condensed milk, and dried milk. The

different milk-borne diseases are also considered, with special attention to both infections of animals that can be transmitted to man and infections primary to man that can be transmitted through milk. The toxicology of milk and milk products is also covered, with particular reference to antibiotics, pesticides, radionuclides, mycotoxins, plant toxins, disinfectants, adulterants, and bacterial enzymes. (auth)

16087 RADIOACTIVITY IN FOODS IN 1967. Miserez, A. Mitt. Geb. Lebensmittelunters. Hyg.: 59: 156-92(1968). (In French).

In absolute value, the degree of contamination of foods including cheese, cereals, fruits, legumes, potatoes, and water, in Switzerland was not essentially different in 1967 from that in 1966. The content of ^{90}Sr in milk, wheat, and farina was reduced in 1967. The mean quantity of ^{90}Sr in milk from the Bern district and powdered milk of the Vaud canton was representative of the whole county. In 1967 it was 16 pCi/l, or 70% of that of the preceding year which was 23 pCi/l. The general arithmetic mean of 17.5 pCi/l is not very different from this partial mean. According to this content, the daily contribution by ^{90}Sr in all the foods can be evaluated at 24 pCi per day/per person. It was 49 pCi in 1966 and four times higher, or 100 pCi, in 1964. The ^{90}Sr content of wheat was in regression with respect to the harvest of 1965. With respect to other foods, the more fragmentary results obtained do not permit any significant difference to be established between 1966 and 1967. The fallout of the Chinese explosions of June and July 1967 were detected in Switzerland principally during the month of July in spite of the relatively low power and the distance of these explosions. Because of their very low radioactivity in these regions, the fallout had practically no effect on foods. (tr-auth)

16088 AVERAGE MILK AND MINERAL INTAKES (CALCIUM, PHOSPHORUS, SODIUM, AND POTASSIUM) OF INFANTS IN THE UNITED STATES FROM 1954 TO 1968; IMPLICATIONS FOR ESTIMATING ANNUAL INTAKES OF RADIONUCLIDES. Durbin, Patricia W. (Univ. of California, Berkeley). Health Phys.; 19: 187-222(Aug 1970).

Dietary intake is one of the parameters needed to test metabolic models relating radionuclide burdens to environmental contamination levels. With respect to ^{90}Sr, the tissues of greatest potential hazard are the infant skeleton and marrow, yet the dietary intake of ^{90}Sr by infants is less well characterized than that for any other population segment. Pertinent information from balance studies conducted in this and other laboratories, dietary surveys, and previously unavailable market research data was collected and summarized. A sample calculation of ^{90}Sr intake is presented for a cohort of infants born in the vicinity of New York City on 1 January 1965; it is based on the calcium intakes in each kind of milk and food month by month through 2 yr of age as developed in this paper, and the published ^{90}Sr analyses of these milks and baby foods purchased in New York City in 1965 and 1966. During the first year of life the average infant in a large U. S. population takes in 320 g calcium: 30.3 g in solid foods, 4.9 g in breast milk, 45.9 g in prepared formulas, 21.6 g in evaporated milk, and 216.3 g in whole cow's milk. During the second year total calcium intake is estimated to be 328 g: 260.4 g derived from whole cow's milk and 67.6 g from solid foods. ^{90}Sr intakes for this cohort were estimated to be 6651 ± 1682 pCi during the first year (1965), with all but 813 pCi contributed by milks, and 5059 ± 718 pCi during the second year (1966). Estimates of both the total calcium and the total ^{90}Sr intakes of this average group were lower than previous estimates based on different dietary assumptions. (UK) (TSS)

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Refer also to abstracts 16227, 16278, 16291, 16306, 16307, 16374, and 16383.

16089 (EUR-4545) APPLICATION OF ATOMIC ENERGY IN AGRICULTURE. Annual Report, 1969. (Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen (Netherlands)). Dec 1970. 85p. Dep. NTIS (U. S. Sales Only). EUR FF 13.80.

Research is reported on applied and scientific aspects of mutation breeding, food irradiation, pest control, and radioisotope techniques in soil-plant research. Mutation breeding studies included effects of x radiation on yield, variations, and flower quality of carnations; x-radioinduced flower color mutants in tulips; mutation breeding of apple, cherry, and pear trees; and experiments on crossing of mutant strains of peas. Adventitious bud techniques were used for studies on prevention of chimerism in x-irradiated potatoes. Studies on mutagenesis in potatoes included effects of neutrons and x radiation on resistance to diseases, pests, and yield. Methods of clonal propagation and culturing of Pyrethrum were studied. Experiments on selection in fast neutron- and γ-irradiated tomato populations are described. Multiple crossing experiments were conducted on x-irradiated barley. Studies on genetics of barley and wheat were conducted following γ irradiation of gametophytes. Progress is reported on effects of radiation on reproductive integrity of tobacco; x-radio-induced mutations in peas; effects of low doses of γ radiation and fast neutrons on barley; irradiation of tomato pollen with thermal neutrons; effects of internal factors on seed irradiation; cytogenetic mapping of neutron- and x-irradiated tomato plants; pollen germination in Pyrethrum; assay of RNAase activity in tobacco tissues; and cytological analyses of Haplopappus tissue cultures. Studies on radiation processing of food included radioresistance of microorganisms; effects of combined radiation and heat on asparagus, spinach, strawberries, peas, beans, and pears; effects of γ radiation on sprouting of potatoes; and irradiation of mushrooms. Research on radiation control of the onion fly using the sterile male technique was continued, and microscopic studies were conducted on testes of irradiated larvae and pupae of the flies. Studies on plant uptake of radionuclides included foliar uptake of ^{22}Na, ^{42}K, ^{86}Rb, ^{134}Cs, ^{137}Cs, ^{85}Sr, and ^{89}Sr by bean plants; role of chloroplasts in the uptake and transport of ^{45}Ca in oat leaves; uptake studies on rice and cotton seedlings; sodium uptake, distribution, and localization in mustard, cotton, and bean plants; and kinetics of ion uptake by intact plants. Studies on migration in soil included development of a model for transport processes; concentration profiles of ^{90}Sr in European pasture soils; migration of ^{45}Ca, ^{137}Cs, ^{22}Na, and ^{90}Sr in soil columns; and studies on nitrogen fixation in bacteria using ^{15}N. Progress is also reported on dosimetry studies, β-spectrometry in relation to ionography, and radiation protection. (H.L.W.)

16090 (NYO-3671-10) RADIATION-INDUCED CHROMOSOMAL INVERSIONS IN MICE. Progress Report, November 30, 1969-November 30, 1970. Roderick, Thomas H. (Jackson Lab., Bar Harbor, Maine). 1 Dec 1970. Contract AT(30-1)-3671. 13p. Dep. NTIS.

Chromosome inversions were detected by x-irradiating sperm of mice and observing the frequency of first anaphase bridges in meiotic cells of their sons. A table is presented to show inversions with their linkage groups and approximate lengths. It was noted also that telophase bridges were very common in inversion heterozygotes. Analysis of linkage groups made it possible to locate the genes dipeptidase-1 (Dip-1) and isocitrate dehydrogenase-1 (Id-1). It is pointed out that inversions act independently in the first meiotic division and that double bridges can usually be seen when they exist. Loci affecting isozyme variations made it possible to use various combinations of inbred strains as linkage testing stocks and to test several linkage groups simultaneously. Inversion differences between subspecies of 6μ were studied. Recessive lethals were revealed by the use of first inversions and a diagram is presented to show a balanced-lethal test system available with In(13)1Rk. Continuation plans are described for further screening and preparation of linkage maps of the mouse by searching for isozyme loci that will be useful in the location of the linkage groups of newly induced inversions. (H.L.W.)

16091 (ORO-678, pp 126-34) EVALUATION OF THE EFFECTIVENESS, EFFICIENCY, AND SPECIFICITY OF VARIOUS MUTAGENIC TREATMENTS. Constantin, M. J.; Conger, B. V. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1-December 31, 1969.

Seeds of barley were given 1400 Rads of fission neutrons. Half of the plants developing from irradiated and unirradiated seeds were decapitated ten days after planting. No influence of decapitation or irradiation was observed on plants of the first and second generations. Experiments to compare effects of γ radiation, fission neutrons, and fast neutrons were conducted on barley. Mutation frequencies were calculated and results indicated that fast neutrons and fission neutrons were equally effective on the basis of chlorophyll deficient mutants. Neutrons were considerably more effective than γ radiation. Seeds of barley were irradiated with fission neutrons and γ rays and treated with EMS and BU. Data on seedling height and chromosome aberrations are tabulated. None of the combined treatments showed an additive response for chromosome aberrations. Maximum damage, seedling height reduction, and chromosome aberrations occurred when irradiated seeds were presoaked 12 hrs prior to EMS treatment. The treatment of irradiated seeds with 5-BU has little or no effect on seedling height reduction and chromosome aberrations. (H.L.W.)

16092 (ORO-3297-4) THE LATE EFFECTS OF ^{90}Sr IN THE MONKEY. Progress Report, 1964-1968. Final Report. Parrott,

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Marshall W.; Felsenfeld, Oscar (Tulane Univ., New Orleans, La.). 22 Apr 1969. Contract AT(40-1)-3297. 30p. Dep. NTIS.

Groups of rhesus monkeys were given ^{90}Sr administered by five possible modes and samples of bone marrow were removed for culture and chromosome analysis after 1324 to 2551 days. The doses of ^{90}Sr administered ranged from single doses of 61 μCi or 152 μCi given by intravenous injection, 12.5 μCi or 18.8 μCi given by daily oral doses to a total dose of 500 μCi, and undetermined amounts received in utero or from mother's milk by nursing infants. The ^{90}Sr body burdens of all animals were determined at intervals by whole-body counting. Accumulated radiation doses to bone varied from 25 to 2060 rod/gm bone. Chromosomes in cultured bone marrow cells from the animals given ^{90}Sr did not differ significantly from those of nonirradiated controls. (C.H.)

16093 RISE OF CHROMOSOMAL ABERRATIONS OF MISGURNUS FOSSILIS L. LARVAE DEVELOPING IN THE ^{90}Sr–^{90}Y SOLUTIONS OF VARIOUS ACTIVITY. Pechkurenkov, V. L. (Research Inst. of Marine Fisheries and Oceanography, Moscow). Genetika; 6: No. 10, 67-78(Oct 1970). (In Russian).

Misgurnus fossilis L. eggs of good quality were incubated in $^{90}Sr-^{90}Y$ solutions from 3.1×10^{-10} to $1.5 \cdot 10^{-10}$ C/l. Overripe eggs of the same species were kept in the 1.3×10^{-6} and 1.5×10^{-4} C/l solutions. Evaluation was carried out according to the quantity of aberrant anaphases and mitotic index. In all variants of the experiment, except the incubation of overripe eggs in the 1.5×10^{-4} C/l solution, no differences from the control variant were observed. While the eggs were being overriped the rate of repair of the chromosomal damages decreased. Comparison of results of all the variants of the incubation of eggs of good quality and overripe ones leads to the conclusion that the frequency of induced mutations becomes equal to that of spontaneous mutations only in the case of incubation of the Misgurnus fossilis eggs in solution of $n \times 10^{-4}$ C/l of activity. Similar conclusions were drawn from the theoretical calculations. (auth)

16094 POLYPLOIDY AND RADIORESISTANCE IN YEAST. I. THE EFFECTS OF MUTATION xrs_{1-5} ON RADIORESISTANCE OF POLYPLOID STRAINS OF SACCHAROMYCES CEREVISIAE. Zakharov, I. A.; Suslova, N. G.; Fedorova, I. V. (Ioffe Inst. of Physics and Tech., Leningrad). Genetika; 6: No. 10, 100-6(Oct 1970). (In Russian).

Highly homozygous stocks of yeast Sacch. cerevisiae are utilized as material for the breeding of two series of polyploids, the normal for radioresistance, and the homozygous for the mutation to x-ray sensitivity. Normal diploid and triploid have the same radioresistance but tetraploid has a slightly higher sensitivity. They are more radioresistant than the wild type haploid. Diploid xrs_{1-5} is less radioresistant than haploid xrs_1. The x-ray and uv-resistance of the mutant polyploids decreases with polyploidy including tetraploidy. It is assumed that the xrs_{1-5} mutants in yeast possess a blocked system for repair of the induced dominant lethals. (auth)

16095 BIOCHEMICAL MUTANTS OF FUSARIUM MONILIFORME (SHELD.). Erokhina, L. I.; Efremov, B. D. (Inst. of Genetics of Industrial Microorganisms, Moscow). Genetika; 6: No. 10, 170-2(Oct 1970). (In Russian).

28 auxotrophic mutants of Fusarium moniliforme with nutritional requirement for methionine, methionine or cysteine, methionine or lysine, cysteine, leucine, arginine, phenylalanine or tyrosine, nicotinic acid, p-amino benzoic acid, adenine were obtained as a result of using γ-irradiation, nitrosoethyl urea, N-methyl-N'-nitro-N-nitrosoguanidine and combined treatment with ethylenimine and uv light. Besides differences in nutritional requirements, biochemical mutants differed in cultural-morphological characteristics, gibberellin production, and frequency of spontaneous mutations to prototrophy. (auth)

16096 CHROMOSOME ABERRATIONS AND RADIATION-INDUCED DEATH OF SOMATIC MAMMALIAN CELLS. Shapiro, N. I.; Mantsygin, Yu. A.; Bagrova, A. M. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 193: 207-10(1 Jul 1970). (In Russian).

In view of the great radiosensitivity of the cells of the nucleus, experiments were carried out to determine the role of nuclear injuries in the radiation-induced destruction of the reproductive ability of somatic mammalian cells. The study involved synchronized Chinese hamster cells in a culture containing cattle serum and antibiotics, grown at 37°C in air containing 5% of CO_2. The cultures were exposed to x radiation. The radiosensitivity of the cells was modified by the addition of a sensitizer and protector, 5-bromodesoxyuridine and cysteamine, respectively. The duration of the mitotic cycle and its various stages were determined. During the metaphase of the first postirradiation division of the cells the chromosomes were examined, and the changes in the LD_{50} values were determined. The results indicated that practically all of the radioinduced reproductive destruction of the somatic hamster cells must be attributed to chromosome aberrations. (TTT)

16097 EFFECT OF SALINE EXTRACTS DERIVED FROM MOUSE TISSUES UPON IRRADIATED HEREDITARY STRUCTURES. Kerkis, Yu. Ya.; Yasnova, L. N.; Urzhenko, A. V. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Dokl. Akad. Nauk SSSR; 186: 195-7(1 May 1969). (In Russian).

Saline extracts were prepared from tissues of irradiated and unirradiated mice and were injected intraperitoneally into mice previously exposed to 4 to 200 R radiation. Anaphase and telophase chromosomes from the corneal epithelium of the mice were examined and it was found that there was an increased number of aberrations in mice that were injected with saline from both irradiated and unexposed mice. (R.V.J.)

16098 GENETICS AND LINKAGE RELATIONSHIPS IN A CROSS BETWEEN AN IRRADIATION-INDUCED SERICEA MUTANT AND ROOT-KNOT NEMATODE RESISTANT LINES, AND EVALUATION OF THE MUTANT FOR CONSERVATION USES. Miller, Jimmy Don. Auburn, Ala.; Auburn Univ. (1970). 75p. University Microfilms Order No. 70-21,112.

Thesis.

Crosses were made between short, dense, profusely branching, mutant sericea (Lespedeza cuneata [Dumont] G. Don) sister lines and two normal lines resistant to Meloidogyne incognita acrita and M. hapla. F_2 of these crosses segregated for nematode resistance, growth habit, earliness, and dwarfs. M. hapla resistance was apparently controlled by three loci. Two of the loci, Mh_1 and Mh_2, exhibited duplicate dominant epistasis and the Mh_3 locus was dominant. M. incognita acrita resistance was controlled by one and two dominant genes, Ma_1 and Ma_2 in different F_2 populations. F_2 populations segregated for three growth habit types: the two parental types and a dense dwarf type with many fine stems. These were controlled by three loci. The dense dwarf type was inherited as a single recessive gene in selfed progeny of short, dense X_3 and X_4 plants. Linkage was tested where possible, and all loci were independent except Ma_1 and e_1 which were linked. An irradiation-induced sericea mutant, along with 4 varieties, were evaluated on highway roadsides in two Alabama locations. It and North Carolina Prostrate were shorter than other varieties. The irradiation-induced mutant had the best appearance ratings for all dates at both locations. (Diss. Abstr.)

16099 LOCALISATION OF RADIATION INDUCED CHROMOSOME ABERRATIONS IN RELATION TO THE DISTRIBUTION OF HETEROCHROMATIN IN SECALE CEREALE. Natarajan, A. T.; Ahnstroem, G. (Univ. of Stockholm). Chromosoma; 30: 250-7(1970).

The distribution of two break chromosome exchanges (dicentrics and centric rings) following gamma or neutron irradiation of resting seeds of rye, Secale cereale, has been investigated. The localization of heterochromatin in the terminal ends of the chromosomes of rye facilitates distinguishing aberrations involving heterochromatin from others. Dicentrics found in or near heterochromatic regions were about 5 times more frequent after gamma irradiation and about 2.5 times more after neutron irradiation, than expected on a random distribution. The implications of these findings in relation to aberration formation are discussed. (auth)

16100 EFFECT OF IONIZING RADIATION ON THE SEGREGATION OF WHEAT HYBRIDS. Sadykhov, A. M. Tsitol. Genet.; 3: 236-42(1969). (In Russian).

Seeds of hybrid wheat were treated with 10 and 15 kR of γ radiation. In first generation plants grown from irradiated seeds a series of recessive characters appeared which segregated in the second generation. More plants with dominant characters, awnless, pubescent, red ear and grain, appeared in the second generation. It was thought that irradiation of the hybrid seeds caused the appearance of dominant characters in the second generation by eliminating gametes with recessive alleles. It is emphasized that irradiation of hybrid seeds can be used for producing favorable genetic combinations in succeeding generations. (auth)

16101 MAMMALIAN CELL GENETICS. III. CHARACTERIZATION OF X-RAY-INDUCED FORWARD MUTATIONS IN CHINESE HAMSTER CELL CULTURES. Chu, Ernest H. Y. (Oak Ridge National Lab., Tenn.). Mutat. Res.; 11: 23-34(Jan 1971).

X-irradiation induced forward mutations from 8-azaguanine sensitivity to resistance in Chinese hamster cells in culture. At this locus the number of induced mutations increased nonlinearly with x-ray exposure. The mutation rate increased from 4.2×10^{-7} per locus per R with 200 R to 1.8×10^{-6} per locus per R with

1200 R. Several factors including cell density markedly influence the mutational yield. Reversion tests using specific chemical mutagens on 72 randomly isolated, azaguanine-resistant mutants suggest that both point mutations and chromosome deletions might have occurred in the hamster cells after exposure to ionizing radiation. (auth)

16102 COMPARATIVE ASPECTS OF THE EFFECTS OF RADIATION DURING OOGENESIS. **Baker, T. G. (Univ. of Edinburgh). Mutat. Res.; 11: 9-22(Jan 1971).**

Primordial germ cells, which are relatively resistant to radiation administered prior or during migration, become sensitive during sex differentiation of the gonad. Sensitivity increases to a maximum during the peak "wave" of mitosis in oogonia, and especially during the final premeiotic division. The oocyte subsequently becomes increasingly resistant to radiation as it progresses from leptotene to pachytene, after which sensitivity increases with the onset of the period of arrested development (diplotene or dictyate stage). Oocytes vary considerably in radiosensitivity with: age, species, inbred or outbred strain, stage of growth of the follicle that surrounds the oocyte, and chromosomal configuration. Those in primordial follicles are highly sensitive in mice, rats, and rabbits; moderately sensitive in dogs, cows, and pigs; and highly resistant in the guinea pig, monkey, and human. The response of oocytes in multilayered follicles is less variable (2000 to 4000 R). Reproductive capacity in the irradiated mammal closely parallels the size of the surviving population of oocytes, but the latter appear to be used more efficiently than in controls. The marked species differences in the response of oocytes cannot be fully explained. The most important factors are now known to be chromosomal configuration and metabolic activity. A hypothesis to explain differential radiosensitivity is described. (auth)

16103 SPECIES COMPARISONS CONCERNING RADIATION-INDUCED DOMINANT LETHALS AND CHROMOSOME ABERRATIONS. **Lyon, Mary F.; Smith, Barbara D. (Medical Research Council, Harwell, Eng.). Mutat. Res.; 11: 45-58(Jan 1971).**

After x-irradiation of post-meiotic stages, male mice, guinea-pigs, rabbits, and golden hamsters differed both in general sensitivity to the induction of dominant lethals, and in the relative sensitivity of the various spermatogenic stages. Guinea-pigs were the least sensitive, and hamsters had a different stage sensitivity pattern, with mature sperm the most sensitive stage. This enhanced sensitivity of mature sperm of hamsters did not apply to translocation induction (as scored in F_1 sons), however, the pattern appeared to resemble that in mice, in which spermatids are the most sensitive stage. Similarly, after triethylenemelamine treatment of male hamsters the pattern of sensitivity to dominant lethal induction in post-meiotic stages resembled that in mice, with mature sperm not the most sensitive stage. Translocations induced in spermatogonial stages were studied cytologically in spermatocytes. Guinea-pigs and rabbits both showed a humped dose– response curve similar to that observed in mice but the peak yield occurred at a lower dose. Hamsters gave a very low yield of translocations. X-ray-induced dominant lethals were also studied in mature oocytes of guinea-pigs and hamsters, which appeared to be at least as sensitive as those of mice. (auth)

16104 MODIFICATION OF GENETIC RECOMBINATION IN ESCHERICHIA COLI K12 BY RADIATIONS AND METABOLIC INHIBITORS. **Wann, Mien. Philadelphia; Univ. of Pennsylvania (1970). 141p. University Microfilms Order No. 70-25,749.**

Thesis.

The observation that three quite different agents (ultraviolet radiation, x radiation and hydroxyurea) give the same kinetics of integration strongly suggests that loss of radioinduced genetic crossing-over represents a stable association of parental DNAs in the zygote. Furthermore, protein synthesis in merozygotes may not be necessary for genetic stabilization since incubation of merozygotes in chloramphenicol (80 g/ml) has little effect on the kinetics of integration. Thus, an adequate amount of integration enzyme(s), if it is necessary for integration, may pre-exist in F^- cells. From experiments utilizing metabolic inhibitors, it may be concluded that DNA synthesis inhibitors (radiations, nalidixic acid, hydroxyurea, and thymine starvation) are able to modify genetic crossing-over in zygotes while protein synthesis inhibitors (chloramphenicol and amino acids starvation) are relatively ineffective. This is consistent with the idea that the action of these DNA synthesis inhibitors is at the level of the chromosomal replication system. Radiations, nalidixic acid, and chloramphenicol produce comparable inactivation of the recipient parent and of recombinants. Therefore, the decrease of recombinant survival by these agents is probably due to lethal damage to the recipient cells and not to inhibition effects operative at the integration level. However, in the cases of hydroxyurea and thymine starvation, production of Thr^+ or Leu^+ recombinant class per viable female cell is decreased as if the integration steps are also inhibited by these treatments. It is estimated that ultraviolet radiation or x-rays may induce more than ten times as much crossover lesions as lethal lesions. In the case of nalidixic acid, the induced crossover density is about seven times the induced lethal lesion density. Both types of lesion densities increase linearly with dose (or exposure time to nalidixic acid). These results are consistent with the idea that lesions which ultimately lead to genetic crossing-over (but not lethality) may be induced in the bacterial DNA. The mechanism by which these lesions affect the genetic recombination may be described by a modified Whitehouse model of crossing-over. A technique for mapping pairs of closely linked markers down to distances of 0.1 minute (in units of transfer time) has been developed which is based on the observations that radiations induce crossing-over lesions proportional to dose and the number of such lesions between two markers is proportional to the physical separation of the markers. (Diss. Abstr. Int., B)

16105 LONG-TERM CYTOGENETIC AND CLINICAL CONTROL OF A CHILD FOLLOWING INTRAUTERINE IRRADIATION. **Kucerova, Maria (Inst. of Experimental Biology and Genetics, Prague). Acta Radiol., Ther., Phys., Biol.; 9: 353-61(Aug 1970).**

The results of a 4-year cytogenetic and clinical control of a child subjected in the fifth and sixth months of pregnancy to a therapeutic roentgen dose for carcinoma of the cervix uteri in the mother are reported. A detailed analysis of chromosome aberrations produced some atypical findings, which are discussed. The mother also underwent cytogenetic investigations. (auth) (Sweden)

16106 GENE CONVERSION IN SYNCHRONOUS YEAST CELL PEDIGREES. **Wildengerg, Judith. New York; City Univ. of New York (1969). 97p. University Microfilms Order No. 70-12,966.**

Thesis.

The general availability of the four products of meiosis has enabled a detailed characterization of meiotic intragenic recombination. While similarities are apparent in the comparable data obtained from mitotically dividing cells, the rare occurrence of such events has necessitated the use of selective procedures. Typically, prototrophic revertant cells are detected as clones on medium deficient for a single growth requirement. Since any auxotrophic products of the revertant cell are not recovered by this technique, the pattern of mitotic events cannot be fully specified. Thus it is uncertain whether mitotic revertants display the same general characteristics that are observed among meiotic revertants. An attempt was made to clarify this problem in a diploid strain carrying two independent histidine-1 mutations in trans array. Closely linked heterozygous markers flank this heteroallelic cistron. Histidine prototrophic revertant cells, rather than clones, were selected among synchronous prereplicative cultures of Saccharomyces cerevisiae. The isolation of the first four mitotic products of each prototrophic cell enables the complete recovery of all of the viable segregants associated with prototroph formation. The genotypes of each of these four cells can then be ascertained by tetrad analysis of the subsequent clones. Non-lethal x-ray doses were used to increase the spontaneous mitotic prototroph frequency. A total of 268 prototroph-containing pedigrees were analyzed for the primary patterns observed among meiotically arising histidine-1 prototrophs. It was concluded that the mechanism of prototroph formation in heteroallelic diploids is fundamentally similar in meiotic and x-ray treated mitotic cells. Additionally, a minimum of about 15% of the mitotic pedigrees contained a second strand in which a conversional event at the histidine cistron was discernible. At least one-half of the total x-ray derived prototrophs were characterized by the absence of a histidine auxotrophic cell. No significant genotypic differences were observed between x-ray derived prototrophs selected at different times during the cell cycle or between prototrophs induced with different non-lethal x-ray doses. An observed variation in the frequency of x-ray induced prototrophs in the absence of DNA replication was attributed to a variation in the synthesis of recombinational enzymes. It is proposed that reciprocal and non-reciprocal products of recombination originate from a single mechanism. (Diss. Abstr. Int., B) (TSS)

16107 MUTATIONS CREATING INTERNAL PROMOTER ELEMENTS IN THE TRYPTOPHAN OPERON OF SALMONELLA TYPHIMURIUM. **Wuesthoff, Gert; Bauerle, R. H. (Southwest Center for Advanced Studies, Dallas). J. Mol. Biol.; 49: 171-96(14 Apr 1970).**

The trp operon of Salmonella typhimurium has the following

structure: p1-0-trpA-trpB-p2-trpE-trpD-trpC. The operon is unique in that in addition to the usual element for initiation of expression (p1) at the operator (0), an internal initiator (p2) exists at or near the trpB-trpE boundary that directs expression of trpE, trpD, and trpC at a low constitutive level. Mutants possessing deletions that extend into the p1-0-trpA end of the operon, terminating before trpB, lack trpB expression yet retain a low constitutive function of trpE, trpD, and trpC genes. It has been possible to restore function of trpB in such deletion strains by the induction of secondary mutations (called Ini) using transition-type mutagens. In such $trpB^+$ (Rax) strains the restored trpB activity in all cases is at a low constitutive level, similar to that determined by p2 for trpE, trpD, and trpC in the deletion parent. The activity of these last three genes in the Rax strains is increased to about the sum of the level restored by the Ini mutation and that determined by p2. The Ini mutations are located exclusively in trpA, in two distinct regions. The Ini mutations could be separated from the p1-0 deletion by recombination, and using such separated Ini strains, it was possible in crosses to reconstruct the original Rax strain as well as new Rax types from different p1-0 deletion strains. The level of trpB expression initiated by the Ini mutation in these genetically constructed Rax strains is the same as in the original Rax strain. The Ini mutations also function as initiators when in combination with strongly polar trpA nonsense and frameshift mutations that lie between 0 and the Ini site. When existing independently, the Ini mutations act as non-critical trpA missense mutations, i.e., they do not impair the activity of the trpA enzyme product and do not significantly alter its sensitivity to end-product inhibition nor its heat inactivation kinetics. All evidence indicates that the Ini mutations, like p2, are low-efficiency promoter elements serving as initiators of transcription. (auth)

16108 NEW HIGH YIELDING OLITORIUS HYBRID. Singh, D. P. (Jute Agricultural Research Inst., Barrackpore, India). Sci. Cult. (Calcutta); 36: 276-8(May 1970).

Mutants of jute, Corchorus olitorius, known as tobacco leaf and long internode were obtained by x radiation. When these two mutants were crossed the resulting hybrid plants were much taller than the parents. Data were obtained for plant height and other characteristics of the F_2 population and results are tabulated. (H.L.W.)

16109 SPECIAL CASE OF LYSOGENY IN MYCOBACTERIUM AVIUM. Hubacek, J.; Kupkova, H.; Mohelska, H. (Inst. of Microbiology, Prague. Research Inst. of Tuberculosis, Prague). Folia Microbiol. (Prague); 15: 341-6(1970).

Phago-producing colonies of cells resistant to homologous phage F4II were isolated after infection of Mycobacterium avium. About 1% phage-free, sensitive clones can usually be obtained after treatment of the cell suspension with phage antiserum. Because of the relatively high free phage titer in the culture, the presence of very dense particles, probably phage equivalents, in the cytoplasm of many cells and the varied sensitivity of intracellular phage to uv irradiation at different stages of growth, it can be assumed that many of the cells in the population burst and liberate phages. The relationship between phage and the host cell is discussed as a particular case of abortive lysogeny. (auth)

16110 EFFECT OF A SINGLE IRRADIATION AT VARIOUS DOSES AND OF A FRACTIONATED IRRADIATION OF OAT SEEDS ON THE YIELD OF CHROMOSOMAL ABERRATIONS. Nuzhdin, N. I.; Dozortseva, R. L.; Samokhvalova, N. S. (Inst. of Biological Physics, Pushchino-Na-Oke, USSR). Dokl. Akad. Nauk SSSR; 191: 1169-71(11 Apr 1970). (In Russian).

Oat seeds were given a ^{60}Co, gamma dose of 7.5 and 15 kR for a single irradiation, and two fractionated doses of 7.5 kR each at a dose rate of 1090 R/min. The time intervals between the first and second fractionated doses were 15, 90, 240, and 450 min. The seeds were also given a single dose of 10 kR at dose rates of 11, 30, 75, 130, 250, 600, and 1090 rads/min. The yield of chromosomal aberrations was found to increase linearly with the log of dose rate. A fractionated dose also leads to a decrease in the yield of chromosomal aberrations. Thus for the first time it was possible to differentiate experimentally the effect of dose rate from the effect of a fractionated dose. (TTT)

Health Physics and Safety

Refer also to abstracts 15764, 15869, 17257, and 17642.

16[illegible] CERTIFICATION SCHEME FOR WELDMENT INSPECTION PERSONNEL. Brit. J. Non-Destruct. Test; 12: 135-9 (1970).

A procedure is described by which personnel may become qualified in relation to weld radiography under the following categories: Industrial Radiographer–Grade II (Welds); Industrial Radiographer–Grade 1 (Welds); Industrial Radiologist (Welded Construction). Requirements for the certification of personnel engaged in the radiographic examination of fusion welded joints in ferrous and non-ferrous wrought and cast materials by x-radiography up to 400 kVp and with conventional x-ray sources are given. (UK)

Radioactive Contamination and Decontamination

Refer also to abstracts 15776, 15874, 16063–16074, 16077, 16078, 16080, 16087, 16088, and 16127.

16112 (AD-711972) GUIDELINES FOR DECONTAMINATION. Final Report, February 12, 1969–July 31, 1970. Bryan, Fred A, Jr.; Cross, Stanley T.; Paddock, Richard E.; Sloan, Bertha T. (Research Triangle Inst., Durham, N. C. Operations Research and Economics Div.). May 1970. Contract DAHC20-69-C-0131. 58p. (RTI-R-OU-444-F). NTIS.

Guidelines for decontamination in postattack situations are developed for inclusion in a handbook type document to be prepared by the Office of Civil Defense. This document, which is expected to be used for preplanning and personnel training, will also be suitable for use by operational personnel. The guidelines are based upon analyses made primarily with the CONSTRIP V Computer Program. These analyses included consideration of facilities and their environments actually occurring in a large metropolitan area (Detroit, Michigan) as well as consideration of theoretical source-shield-detector configurations. Results indicate that effects of source field decontamination are significant for distances up to 200 feet from a facility. (auth)

16113 (AEC-tr-7172) INFLUENCE OF PROPHYLACTIC INHALATION OF PENTACIN ON THE REMOTE AFTEREFFECTS OF ^{239}Pu INHALATION. Koshurnikova, N. A.; Lyubchanskii, E. R. Translated by A. A. Horvath (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.), from Med. Radiol.; 14: 29-34(1969). 11p. Dep. CFSTI.

An abstract of the original article appeared previously in Vol 23 issue 24 of NSA as abstract number 50621. The title of the original article was "The Remote Sequelae of ^{239}Pu Inhalation in the Inhalation of Pentacine." (E.R.B.)

16114 (HASL-239, pp II.1-129) HASL FALLOUT PROGRAM DATA. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

From Fallout Program quarterly summary report, September 1–December 1, 1970.

Data from the HASL fallout monitoring program are presented and include: 1970 measurements of ^{90}Sr in New York City and San Francisco diets; 1969 and 1970 measurements of ^{90}Sr in human bones from Africa and South America; Oct. 1969 and Jan. 1970 measured data on the total gamma activity and radioisotopes (^{144}Ce, ^{210}Pb, ^{210}Po, ^{238}Pu, ^{239}Pu, ^{89}Sr, ^{90}Sr, and ^{95}Zr) content in the Western Hemisphere lower stratosphere based on aircraft-collected samples; and the stratospheric concentrations of ^{144}Ce, ^{55}Fe, ^{238}Pu, ^{239}Pu, ^{89}Sr, ^{90}Sr, and ^{95}Zr based on analyses of samples collected with high altitude balloons in the stratosphere over Australia and North America from Jan. 1969 to June 1970. The air sampling procedures and the effects of weight of filter paper on the collecting efficiencies of the samplers are discussed. (L.C.L.)

16115 (NP-18513) RADIOACTIVE CONTAMINATION: PERMISSIBLE LIMITS, PREVENTIVE MEASURES, AND DECONTAMINATION. Ragusa, Salvatore (Ente Nazionale Prevenzione Infortuni, Rome (Italy)). Mar 1964. 294p. (In Italian). Dep. NTIS (U. S. Sales Only).

The book is written for those with a basic understanding of physics and nuclear technology who must deal with questions of the evaluation of radiation dangers and precautions against them. Contamination and permissible limits are defined and the values accepted for various isotopes in air and water are tabulated and discussed. The sources of contamination in mines, nuclear plants, radioisotopic laboratories, medicine, industry, agriculture, and transportation are illustrated and the preventive measures taken in each area are discussed. The methods used for the measurement of the contamination of the environs and the human body are described. Methods of decontamination of materials and of persons are given. The formation and disposal of gaseous, liquid, and solid wastes are discussed. (J.S.R.)

16116 UPTAKE OF NITROSYL ^{106}Ru ON CHITIN AND CHITOSAN FROM WASTE SOLUTIONS AND POLLUTED SEA-

WATER. Muzzarelli, Riccardo A. A. (Univ., Bologna). Water Res.; 4: 451-5(Jun 1970).

Chitin and chitosan, two polymers obtained from crab shells, were proposed as chromatographic supports for collection of nitrosyl ruthenium from radioactive waters. The polymers can also find applications for the pollution survey of seawater. (auth) (UK)

16117 TESTS FOR THE EVALUATION OF AIRBORNE HAZARDS FROM RADIOACTIVE SURFACE CONTAMINATION. Shapiro, Jacob (Harvard School of Public Health, Boston). Health Phys.; 19: 501-10(Oct 1970).

An analysis was made of the magnitude of airborne activity resulting from radioactive surface contamination under various resuspension mechanisms. The level of airborne activity is considered to depend on two factors, the fraction of particles dispersed per unit time (given by a dispersion factor) and the residence time of the activity in the air. Calculations are made for the air activity for steady state resuspension and for transient distributions based on single dispersal processes. Expressions for the resuspension factor are also derived. It is shown that under the usual conditions of ventilation, the resuspension factor depends primarily on the dispersion factor and ventilation and not on the settling properties of the particles, except for very large particles that settle out rapidly. Laboratory tests for evaluation of the dispersion factor and the residence time for various dispersion mechanisms are described. It is concluded that the most significant test from the viewpoint of routine operations determines the fraction of the surface contamination released to the air when a contaminated surface is repeatedly brought into contact with another surface and separated from it. The dispersion test must be combined with measurements of the residence time in a settling chamber to provide data applicable to hazard evaluation of contamination in field situations. (auth)

16118 SUMMARY OF RADIATION ACCIDENTS IN ATOMIC ENERGY ACTIVITIES OF KOREA. Lee, Hyun Duk; Ha, Chung Woo. J. Korean Nucl. Soc.; 2: 97-106(Jun 1970). (In Korean).

Radiation accidents that occurred in the A.E.R.I. during the last ten years are summarized. The following four major accidents involving contamination incidents are described: whole-body exposures up to 130 rem due to mishandling of the ^{60}Co γ radiation facility; floor surface contamination (up to 13 mrad/hr) and its spreading due to mishandling of a bottle containing radioiodine; body surface contamination and accumulation of 0.36 μCi radioactivity in the thyroid gland of a worker due to inhalation of gaseous ^{131}I: leakage of radium from a therapeutic capsule. The accidents were treated promptly to protect the workers against radiation hazards and efforts were made to control the spread of contamination. (auth)

16119 SUBSTANTIATION OF THE MAXIMUM PERMISSIBLE CONCENTRATIONS OF AMMONIUM DIURANATE IN THE AIR OF INDUSTRIAL PREMISES. Galibin, G. P.; Vlasov, P. A. Gig. Sanit.; No. 5, 26-32(May 1970). (In Russian).

In a chronic test carried out on rats, inhalation of ammonium diuranate at a concentration of 8 mg/m^3 for 4 hr daily for a period of 4 months proved to be definitely toxic. The concentration of this compound amounting to 1 mg/m^3 approached the minimum effective level obtained in the chronic inhalation test. Data on clinical, biochemical, and patho-anatomical investigations and the amount of substance absorbed by such tissues as the skeleton, lungs, liver, and kidneys are presented. On the basis of the experimental data obtained the maximum permissible concentration of ammonium diuranate in the air of industrial premises is recommended to be set at a level of 0.1 mg/m^3 of uranium (7 to 10^{-14} Ci/l for natural uranium). (auth)

16120 RADON HAZARD IN UNDERGROUND WORK AT URANNIUM AND NONURANIUM MINES. Bykhovskii, A. V.; Chesnokov, N. I.; Khachirov, Dzh. G. (Inst. of Medical Radiology, Obninsk, USSR). Gig. Sanit.; No. 5, 40-5(May 1970). (In Russian).

Analysis of published data and that of personal observations point to the existence of a radiation hazard in both uranium and nonuranium mines and to the possibility of its prevention by existing technical means. (auth)

16121 CORRELATION BETWEEN CONCENTRATION OF ^{137}Cs IN THE HAIR AND THAT IN THE BODY. Antonova, V. A.; Shvydko, N. S.; Lisachenko, E. P. Gig. Sanit.; No. 45-8(May 1970). (In Russian).

Data are presented to show a definite correlation between ^{137}Cs concentration in the hair and in muscular tissue. Measurements were made in vivo and from autopsy material. A regression equation was obtained that makes it possible to use the specific activity of ^{137}Cs in the hair to assess the specific activity of the isotope in the body. The concentration of ^{137}Cs in the hair was shown to be independent of the age and sex of the person. (auth)

16122 TECHNIQUE FOR DETERMINING THE ACTIVITY AND SIZE DISTRIBUTION OF β-EMITTING DUST PARTICLES USING AUTORADIOGRAPHY. Matsui, Hiroshi (Japan Atomic Energy Research Inst., Tokai). Radioisotopes (Tokyo); 19: 539-45(Nov 1970). (In Japanese).

A technique is described for determining the activity and size distribution of β-emitting dust particles using autoradiography. An x-ray film is more sensitive to β rays and more useful than the nuclear emulsion in the β-ray autoradiography. Variations of the black spot diameter with the development time and temperature were within a few percent for the deviation of ±0.1 min and ±0.5°C from the standard condition respectively. About fifty micron thick separator of Lyphan did not cause any variation of the spot size for β rays from fission product nuclides. Error in estimating the activity and size distribution of β emitting particles by autoradiography is discussed. The application of the present technique to aerosol analysis is described showing an example. (auth)

16123 COMPUTER PROGRAM FOR AUTOMATIC DETERMINATION OF RADIOACTIVITY IN THE HUMAN BODY. Linden, W. A.; Schneider, C.; Wegener, O.-H. (Univ., Hamburg. Strahleninstitutes, Hamburg). Atompraxis; 16: 330-2(Sep-Oct 1970). (In German).

To account for body configuration in an automatic computing program of radioactivity, the influence of body contour on the sensitivity of a whole-body counter containing four stationary detectors was studied in phantoms and in patients. Measurements were substantially influenced by the mean diameter of the object. Based on a linear relation between accuracy and mean body diameter (weight/length) a correction formula is given for ^{75}Se, ^{132}Cs, and ^{40}K. By use of this formula the precision of the computing program was greatly enhanced. The formula can be easily adapted for similar whole-body counters. (auth)

16124 MANGANESE CONTENT AND THE OCCURRENCE OF FALLOUT ^{54}Mn IN SOME MARINE BENTHOS OF THE MEDITERRANEAN. Chipman, Walter (International Lab. of Marine Radioactivity, Monaco); Thommeret, Jean. Radioact. Sea; No. 28, 1-15(1970).

Reprinted from Bull. Inst. Oceanogr.; 69: 1402-14(1970).

In 1966, the ascidian, Halocynthia papillosa, the lamellibranch mollusc, Pinna nobilis, and the annelid worm, Hermione hystrix, were found to have relatively high content of ^{54}Mn. Detectable amounts of ^{54}Mn were present in the ash of the tube worm, Spirographis spallanzani. The radionuclide was not detected in other species tested, which included the anemone, Anemonia sulcata, the lamellibranch, Tapes decussatus, the holothurian, Holothuria tubulosa, and the ascidian, Phallusia mammilata. In Pinna the highest concentration of ^{54}Mn was in the hepatopancreas. In polychaete worms manganese seems to be concentrated in the external body structures, such as in the cuticle of Hermione. Although high radioactivity from fallout ^{54}Mn was generally related to a high manganese content in the organism, the specific activity of the ^{54}Mn (amount of $^{54}Mn/\mu g$-Mn) varied. That of the ash of Pinna was more than twice that of the ash of Halocynthia, though the total ^{54}Mn radioactivity was the same. The body of the worm Spirographis had detectable radioactivity from ^{54}Mn whereas the tube of the worm, with three times more manganese, did not. Among fallout radionuclides that were also found, ^{147}Pm seemed to be present in those organisms that concentrate ^{54}Mn. (auth)

16125 RADIOLOGIC STUDY OF INORGANIC URINARY CALCULI. II. COMPARISON OF STABLE AND RADIOACTIVE STRONTIUM DEPOSITION IN URINARY CALCULI AND HUMAN DIET. Herring, Louis C.; Keefer, Douglas H. (Louis C. Herring and Co., Orlando, Fla.). Arch. Environ. Health; 22: 251-8(Feb 1971).

Composite samples consisting of 50,000 inorganic urinary calculi were assayed for stable strontium and ^{90}Sr and correlated with the ^{90}Sr-calcium ratios found in the human diet between 1962 and 1966. Diet data reported by the Public Health Service, Atomic Energy Commission, Food and Drug Administration, and Consumers Union show a national mean dietary ^{90}Sr level of 19.5 pCi of ^{90}Sr per gram of calcium during this period. A collective comparison of national diet data shows that urolithiasis patients were consuming approximately three times the concentration of ^{90}Sr and stable strontium was found to be present in a collection of urinary calculi. (auth)

XUM

Dosimetry and Monitoring

Refer also to abstracts 15786, 15806, 16075, 16092, 16255, 16263, and 16317.

16126 (AD-713557) REDUCTION OF BIOLOGICAL EFFECTIVENESS OF X RAYS AT VERY HIGH DOSE RATES. Kronenberg, Stanley; Lux, Robert; Nilson, Kristian (Army Electronics Command, Fort Monmouth, N. J. Inst. for Exploratory Research). 1970. 12p. NTIS.

It has been observed that relative biological effectiveness (RBE) of x-rays or gamma rays is independent of dose rate provided that their delivery time is short compared to the recuperation time of the organism. At higher dose rates, however, several effects may modify the RBE. One possible process is considered here: Biological radiation effects are dependent upon the chemical behavior of free radicals produced in the ionization process. These free radicals are usually chemically active, and can produce permanent damage by their interaction with protein chains. Suppose the concentration of these radicals is allowed to come to equilibrium by irradiating a sample at a constant dose rate for a sufficient time. For low and moderate dose rates the radical concentration is so low that direct radical-radical recombination may be neglected. At a sufficiently high dose rate however this recombination may become significant. The reduced radical concentration will reduce the RBE. (auth) (USGRDR)

16127 (AEC-tr-7214, pp 27-36) PREDICTION OF RADIATION EXPOSURE TO THE NATIVES OF THE FAR NORTH FROM INCORPORATED ^{137}Cs. Moiseev, A. A. Translation of A-AC-82/G/L-1198.

From USSR reports on radioactivity in man and the environment.

Formulas and calculations of the dose coefficients which make it possible to evaluate integral absorbed doses at any period of time (from one to 70 years) from the ^{137}Cs body burden in a reindeer herdsman are presented. The calculations are based on the assumption that ^{137}Cs fallout from the atmosphere to the ground is essentially complete. Isotope elimination from the reindeer meat which is the main source of ^{137}Cs in the diet for the natives of the far north, follows an exponential law. Results of the calculations are given in the form of a table and charts that can assist in predicting the dynamics of tissue doses from incorporated ^{137}Cs. (auth)

16128 (AHSB(RP)R-105) ENVIRONMENTAL MONITORING ASSOCIATED WITH DISCHARGES OF RADIOACTIVE WASTE DURING 1969 FROM UKAEA ESTABLISHMENTS. Wray, E. T. (ed.) (United Kingdom Atomic Energy Authority, Harwell (England). Authority Health and Safety Branch). Oct 1970. 22p. Dep. NTIS (U. S. Sales Only).

Results of the monitoring programs carried out in connection with radioactive waste discharges from the principal establishments of the UKAEA in 1969 are summarized. The information given includes the essential features of the authorizations for discharges in force at each establishment together with details of the actual discharges which were made and the results of environmental monitoring. The latter results are compared with derived working limits to facilitate an appreciation of the standards of safety achieved. (auth)

16129 (BNWL-1505) EVALUATION OF RADIOLOGICAL CONDITIONS IN THE VICINITY OF HANFORD FOR 1969. Wilson, C. B.; Essig, T. H. (eds.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1970. Contract AT(45-1)-1830. 73p. Dep. NTIS.

At the Hanford plant, controlled releases of a variety of low-level radioactive wastes are made to the Columbia River, to the ground, and to the atmosphere. The major source of low-level wastes released to the environment in 1969 continued to be reactor cooling water discharged to the Columbia River. The combined offsite effects of all radioactive wastes released from Hanford during 1969 were evaluated in terms of the radiation doses received by nearby population groups. Dose estimates for 1969 were generally lower than 1968 values. As in the annual report for 1968, the appropriate representatives of the population were considered to be the Maximum Individual and the Average Richland Resident. Doses were estimated for the skeletal bone, whole body, gastrointestinal tract, and thyroid. These estimated doses were less than one-tenth of the appropriate standards with the largest percentage of standard being that for the skeletal bone of the Maximum Individual (9% of the 1500 mrem/yr standard). A single radionuclide, ^{32}P, contributed 92% of this estimated skeletal bone dose with Columbia River fish the major source of intake. Unusually high concentrations of radionuclides were observed in a duck collected from a reactor cooling water trench, but were not representative of concentrations in gamebirds available to the public, based on routine sampling near public hunting areas. (auth)

16130 (BRH/DBE-70-4) DOSES TO THE CENTRAL NERVOUS SYSTEM OF CHILDREN RESULTING FROM X-RAY THERAPY FOR TINEA CAPITIS. Lee, Wah; Youmans, H. D. (Bureau of Radiological Health, Rockville, Md.). Oct 1970. 15p. NTIS.

X-ray beam qualities of 72 to 118 kVp with HVT's of 0.66 to 3.9 mm Al were used to irradiate three head phantoms constructed from the skulls of 3-, 6-, and 12-year-old children using Mix D as soft tissue equivalent material. Thermoluminescent dosimeters were used for in phantom exposure measurements. A relatively simple method was developed which yields an accurate estimation of dose distribution in the brain and doses to the eye and thyroid of children (ages 3 to 12) irradiated with any x ray technique commonly employed for the treatment of tinea capitis. Typical ranges of doses to the organs of the head are: brain, 100 to 200 rads; lens of eye, 10 to 25 rads; and thyroid, 2 to 5 rads. (auth)

16131 (EUR-4563) ENVIRONMENTAL RADIOACTIVITY, ISPRA 1969. de Bortoli, M.; Gaglione, P. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1970. 50p. Dep. NTIS (U. S. Sales Only). EUR FF 7.75.

The measurements of environmental radioactivity performed during 1969 by the site survey group of the Protection Service of the Euratom Ispra Establishment are briefly described. Data are given on the concentrations of ^{90}Sr, ^{137}Cs, and other radionuclides in precipitation, air, waters, herbage, and foods. The origin of the contamination is mainly world-wide fallout. (auth)

16132 (HASL-239(App.)) FALLOUT PROGRAM. Quarterly Summary Report, September 1-December 1, 1970. Appendix. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Jan 1971. 405p. Dep. NTIS.

Data are presented on the following phases of the HASL fallout program: the ^{89}Sr and ^{90}Sr in monthly deposition at world land sites through June 1970, the ^{90}Sr deposition at Atlantic Ocean weather stations through June 1970, the radionuclide and stable lead content of surface air at selected sampling stations in the western hemisphere through May 1970, and the ^{90}Sr content of milk and tap water in New York through September 1970. Tables of conversion factors and the half-life of radioisotopes used in the report are also included. All data are presented in tabular form. (E.R.B.)

16133 (HASL-239, pp III.36-9) ^{137}Cs IN VARIOUS CHICAGO FOODS (COLLECTED MONTH OCTOBER 1970). Brar, S. S.; Nelson, D. M. (Argonne National Lab., Ill.).

From Fallout Program quarterly summary report, September 1-December 1, 1970.

The ^{137}Cs content of human adult and infant diets in Chicago during October 1970 is presented. The individual components of each diet were grouped according to type of food (fruit, meat, etc.). The results for both age groups, along with the potassium content are presented in tabular form. (E.R.B.)

16134 (JPRS-52121, pp 51-7) MICRODISTRIBUTION OF ABSORBED DOSE IN THE TRACK OF A HEAVY CHARGED PARTICLE. Kudryashov, E. I.; Marennyi, A. M.; Popov, V. I.; Meshcheryakova, O. M. Translated from Kosm. Biol. Med.; 4: No. 5, 35-9(1970).

During distant space flights, personnel may be exposed to considerable fluxes of heavy nuclei from galactic radiation. It is assumed that in an evaluation of the radiation danger of such nuclei it is necessary to take into account both the linear energy transfer to the tissue and the radial distribution of absorbed energy in the particle track. Computations for different energies of the initial particle and several hypothetical minimum energy levels for secondary electrons were made. An expression was derived for the radial distribution of absorbed energy in a charged particle track. (E.E.H.)

16135 (NP-18514) X RAYS: PROTECTION, DOSIMETRY, AND PRECAUTIONS. Venier, A. (Ente Nazionale Prevenzione Infortuni, Rome (Italy)). 1964. 282p. (In Italian). Dep. NTIS (U. S. Sales Only).

A general review is given of the protection, dosimetry, and precautions utilized during the use and application of x rays. The constitution of matter and the characteristics of x rays are reviewed. The attenuation and measurement of radiation in its passage through matter is discussed. The effects of x radiation on living matter is considered. In the discussion of the natural permissible dose, the natural radiation background, population dose, and dose for persons professionally exposed are reviewed. The physical monitoring for protection and medical monitoring are

described. Personnel accessories for protection against x radiation are described. The protection and prevention standards for medicine and industry are given. (J.S.R.)

16136 (NP-18590) AN ESTIMATE OF THE GENETICALLY SIGNIFICANT DIAGNOSTIC ROENTGEN-RAY DOSE IN THE NETHERLANDS (1967). Beentjes, Lucas B. (Nijmegen Univ. (Netherlands)). 100p. Dep. NTIS (U. S. Sales Only).

Studies were made to establish the genetically significant dose in the Netherlands for the year 1967 due to diagnostic radiology. The present study uses information on one million x ray examinations. Health insurance companies provided data on 250,000 x ray examinations regarding the age and sex of the patient and the type of examination performed. The frequency distribution, derived from the data of the insurance companies, is discussed. It was found that .37 roentgen examinations are performed per inhabitant per year. This figure varies regionally in the areas investigated from .25 to .45. Mass miniature radiography adds .21 making the total .58. A treatment and derivation of suitable child expectancy tables are given. The treatment is a refinement of the conventional approach. Gonad doses measured by four different investigators are discussed in relation to standard conditions for the Netherlands. The estimated value for the annual genetically significant dose in the Netherlands is 20 mrem with large margins of error (-20%, +100%) mainly due to uncertainties regarding the field size discipline. This dose is of such an order of magnitude as to appear important enough for attempts to be made at its reduction. Genetic detriment can thus be decreased. Next to field size discipline the importance of proper filtration is stressed, with detailed data on its effects. (P.B.M.)

16137 (NP-18658) REPORT ON SOME ASPECTS OF RADIATION PROTECTION AND POPULATION EXPOSURE IN THAILAND. (Ministry of Public Health, Bangkok (Thailand). Radiation Protection Service). [1970]. 44p. Dep. NTIS (U. S. Sales Only).

The general organization of radiation protection in Thailand and the activities of the Thai Radiation Protection Service are described. This has a special interest in that Thailand is one of the few developing countries to have provided for radiation protection and calibration services on a national scale. It may be interesting to compare the data resulting from this with equivalent material from the operation of similar organizations in more developed countries. The more detailed material presented here includes the results of monitoring occupational exposures; preliminary results of a national survey of numbers and types of x-ray examinations analyzed by ages and sex of patients; some indicative data from a long-term study of doses to patients in diagnostic x ray examinations; and speculation on the possible genetic dose to the population of Thailand from diagnostic radiology. (auth)

16138 (ORNL-TM-3134) QUARTERLY PROGRESS REPORT ON RADIOLOGICAL SAFETY OF PEACEFUL USES OF NUCLEAR EXPLOSIVES: TRANSFER OF TRITIUM TO MAN FROM AN INITIAL WET DEPOSITION. Kelly, M. J.; Booth, R. S. (Oak Ridge National Lab., Tenn.). 8 Jan 1971. Contract W-7405-eng-26. 22p. Dep. NTIS.

The total dose to man from tritium contamination of soil was estimated by simulating the movement of tritium through the soil after an initial wet deposition as a diffusion process with a superimposed translation caused by rainfall. Only experimentally demonstrable constants were incorporated into the model, and it was qualitatively tested against experimental results. Instantaneous equilibrium was assumed between the tritium concentration in the soil compartment and the food that man eats. It was concluded that, except for the desert, the time-dependent concentration of tritium in the soil compartment is primarily determined by the rainfall after the deposition, and it is essentially independent of the assumed compartment depth. Consequently, a simple chart could be made for estimating the total dose to man from a given wet deposition source and the subsequent rainfall rate. (auth)

16139 (RISO-220) ENVIRONMENTAL RADIOACTIVITY IN DENMARK IN 1969. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jun 1970. 95p. Dep. NTIS (U. S. Sales Only).

An account is given of the measurement of fallout radioactivity in Denmark during 1969. Strontium-90 was determined in samples from all over the country of precipitation, soil, ground water, sea water, grass, dried milk, fresh milk, grain, bread, potatoes, vegetables, fruit, total diet, drinking water, and human bone. Furthermore ^{90}Sr was determined in local samples of air, rain, water, grass, sea plants, fish, meat, and human milk. Cesium-137 was determined in milk, grain products, potatoes, vegetables, fruit, total diet, meat, and human milk samples, and was also measured by whole-body counting in persons from a control group at Risö. Estimates of the mean contents of radiostrontium and radiocesium in the human diet in Denmark during 1969 are given. The γ-background was measured regularly at locations around Risö, at ten of the State experimental farms and in an area in Zealand, one at Jutland where future nuclear power plants might be located, and along the shores of the Great Belt. The report also includes, as previously, regular surveys of environmental samples from the Risö area. (auth) (Denmark)

16140 (RT/PROT-(70)9) POSSIBILITY OF BIOLOGICAL DOSIMETRY BY MEANS OF URINARY BIOCHEMICAL INDICATORS ON ACCIDENTAL EXPOSURE TO IONIZING RADIATION. Di Pofi, M. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari). [1967]. 16p. (In Italian). (CONF-681047-3). Dep. NTIS (U. S. Sales Only).

From 31st Conference of the Italian Industrial Medical Society, Bologna, Italy.

After analyzing the main characteristics required for a biological dosimetry in man after a total exposure to ionizing radiations, the substances till now studied and especially the urinary dosage of the deoxicytidine and of the 5-hydroxyndolacetic acid are examined. These substances could be determined in every case of accidental irradiation where equivalent doses of at least 50-100 rem are administered to the whole body as an addition of physical measures and clinical examinations. (auth)

16141 (SZS-17/70) ELECTRON MICROSCOPIC INVESTIGATIONS OF RADIOACTIVE AEROSOLS IN SPECIAL WORKING AREAS. REQUIREMENTS ON AIR MONITORS FOR WORKING PLACES. Maiwald, E. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Sep 1970. 18p. (In German). Dep. NTIS (U. S. Sales Only).

A technique is described for the preparation of combined filters from millipore and chloroethylene fibrous filter materials. It allows an air sample to be taken from which measurements are possible of both particle size distribution by electron microscopy and aerosol activity. From the results of measurements in different working areas it can be seen to what extent aerosol size distribution leads to different values of internal exposure. (auth)

16142 (UCRL-20190) MEASUREMENT OF OXYGEN EFFECT AND BIOLOGICAL EFFECTIVENESS OF A 910-MeV HELIUM ION BEAM USING CULTURED CELLS (T1). Raju, Mudundi R.; Gnanapurani, Madhvanath; Martins, Bambino; Howard, Jerry; Lyman, John T. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov 1970. Contract W-7405-eng-48. 13p. (CONF-701103-7). Dep. NTIS.

From 63rd National Meeting of the American Institute of Chemical Engineers, Chicago, Ill.

The depth-dose distribution of a 910-MeV monoenergetic helium ion beam is modified by using a ridge filter in the beam path so that the region of maximum dose is uniform over a distance of about 6 cm of water. The biological effectiveness and oxygen enhancement ratio (OER) at different depths within a rectangular Lucite phantom were measured by using cultured human kidney cells (T-1). The results indicate that the biological effectiveness at the broad peak region is about 1.3 to 1.4 compared with that at the beam entrance, and the OER is found to be about 1.7 to 1.9. This significant reduction in OER even when the beam is modified to cover 6 cm of tissue may be of radiotherapeutic interest in treatment of deep seated tumors containing hypoxic cells. (auth)

16143 (UCRL-50007-70-2) HAZARDS CONTROL PROGRESS REPORT NO. 37, MAY-AUGUST 1970. (California Univ., Livermore. Lawrence Radiation Lab.). 29p. Dep. NTIS.

The status of research programs on radiation protection is briefly summarized. Separate publications will report the final results of these activities. Activities on which further reporting is not anticipated include: the development of a method for measuring the atmospheric diffusion of tritium, or other radioactive material, at various locations downwind from the source following release in stack gas; an evaluation of the efficiency of stack gas and atmosphere tritium monitors; the use of a Monte Carlo Neutron Transport Code (SORS) to calculate the moderated fast neutron spectra of ^{252}Cf in spheres of D_2O and reactor-grade graphite; calculations of the dose rate of ^{252}Cf in D_2O spheres; and the use of a desk-type computer to calculate the ^{60}Co γ dose distribution from an array of source pencils suspended in water in a cylinder. (C.H.)

16144 SIZE EFFECT OF ^{60}Co SOURCES (1 AND 2 cm) ON LENGTH OF FIELD, WIDTH OF PENUMBRA, DOSE DISTRIBUTION, AND DEFINITION OF BEAM FOLLOWING IRRADIATION WITH AND WITHOUT PENUMBRA TRIMMERS: PHOTOMETRIC STUDIES ON PHANTOMS. Weishaar, Julius; Heckel, Volker;

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Reuss, Albrecht (Univ., Erlangen, Ger.). Strahlentherapie; 140: 173-84(Aug 1970). (In German).

Photometric studies show that dose limitations are better, the 100% zone is larger, and the penumbra is smaller for ^{60}Co sources of 1 cm diameter than for sources of 2 cm. This effect is even enhanced by the use of penumbra-trimmers. With a source of 1 cm, the linear dose reduction is only 60 to 65% of the reduction obtained for a source of 2 cm. The advantage of better defined beams for therapy is stressed. It seems even advisable to use small sources for apparatuses with large pendular axes. (auth)

16145 COMPUTATION OF DEPTH DOSE CURVES FOR WATER AND GRAPHITE PHANTOMS IRRADIATED WITH 1250 keV PHOTONS. Eisenlohr, H. H. (International Atomic Energy Agency, Vienna). Strahlentherapie; 140: 185-9(Aug 1970). (In German).

Depth dose curves are calculated for 1250 keV photon radiation in water and graphite. It is assumed that only compton electrons contribute to the absorbed dose and that their kinetic energy decreases linearly along their tracks. The dose maximum in water is at 0.34 cm, in graphite at 0.18 cm depth. (auth)

16146 USE OF OPTIC PANTOGRAPH TO REDUCE TRANSVERSAL TOMOGRAMS TO NORMAL SIZE. Nordman, E.; Rekonen, A. (Central Hospital, Jyvaeskylae, Finland). Strahlentherapie; 140: 190-1(Aug 1970).

An optic pantograph, originally designed for map drawing, was used to produce natural-size copies of x-ray tomograms. Maximum enlargement or reduction was 1 to 4.5. On the pulmonary tomograms, tumors could be visualized in normal size and dose planning for x-ray therapy could be charted accurately. (H.B.G.)

16147 ELECTRON DEPTH THERAPY WITH PENDULUM IRRADIATION. IV. A NEW TECHNIQUE FOR SMALL ANGLE PENDULUM RADIATION WITH A PRIMARY HOMOGENEOUS ELECTRON BEAM. Rassow, Juergen (Ruhr Univ., Essen). Strahlentherapie; 140: 156-72(Aug 1970). (In German).

The electrons with maximal energy leave the betatron in the orbital plane. In order to obtain homogenization for large fields, these electrons should be scattered in the Siemens-betatron. This reduces the homogeneity in the orbital plane and also the depth-dose. A new method for homogenization is described. Examples of optimization are shown for 18 calculated depth-dose distributions for electrons of 43, 30, and 10 MeV. Using the advantage of primary unscattered electrons for small fields, one can obtain, by telecentric movement of the central ray during pendular movement, a better dose distribution than for the pencil beam scanning system with magnetic deflection of parallel electron beams. The field width and length can be chosen continuously. The maximal dose for 43 MeV lies at 11 cm, 80% at 17 cm, with a rapidly decreasing dose thereafter. Because of the small pendular angle, the dose gradient at the field edge corresponds to the static fields. This method gives sometimes a better dose distribution than the conventional pendular technique and can also be used in cases where, because of geometrical reasons, only single or multiple field irradiation could be applied. (auth)

16148 EVALUATION OF RADIATION DOSES TO BODY TISSUES FROM INTERNAL CONTAMINATION DUE TO OCCUPATIONAL EXPOSURE. Report of ICRP Committee IV. Radiation Protection. ICRP Publication 10. Oxford; Pergamon Press (1968). 98p. 30s.

Current knowledge of the metabolism of radionuclides and mathematical descriptions of this metabolism, with methods and programs of monitoring and with quantitative guides for assessing internal exposures are dealt with. Appendixes contain metabolic information, mathematical formulation of retention of radionuclides, and detailed information about the metabolism of approximately thirty radionuclides that are most frequently encountered as internal contaminations of workers. (47 references) (UK)

16149 DOSE DISTRIBUTIONS IN ROTATION IRRADIATION WITH A REGULAR SPEED. Pavlov, A. S.; Pereslegin, I. A.; Khrushchov, M. M.; (and others). Med. Radiol.; 15: No. 10, 63-9(Oct 1970). (In Russian).

A method of rotation irradiation with a regulating speed is investigated and compared with usual rotation and multifield static irradiation. The investigations are carried out on "Rokus" apparatus supplied with a device that was able to change the speed of rotation by 50 times. The dose distribution was defined on a cylindrical phantom, as well as on a phantom of the pelvis and chest. It is concluded that rotation irradiation with controlled speed enables active formation of the dose field applicable to the patient's treatment. Irradiation with controlled speed in comparison with routine rotation irradiation is progressive and in certain conditions by the character of the formed dose fields may approach the advantages of multifield static irradiation. Rotation irradiation with controlled field creates favorable prerequisites for the automation of the process of radiation treatment. (auth)

16150 THERMOFLUORESCENT MEASUREMENT OF DEPTH ABSORBED DOSES OF LONG-WAVE RADIATION. Gubatova, D. Ya. (Inst. of Physics, Riga). Med. Radiol.; 15: No. 10, 69-72(Oct 1970). (In Russian).

The percentage of absorbed depth radiation doses obtained on TuR T-60-2 roentgenotherapeutic apparatus (tension at the tube — 15, 30 and 60 kV) was determined with the aid of a thermofluorescent dosimeter on the basis of lithium fluorate. The investigation was carried out in a tissue-equivalent 1.6% aqueous solution of table salt. Curves of weakening of radiation obtained in the above-mentioned conditions and layers of half-weakening in a tissue-equivalent solution are presented. A comparison with the calculated percentage depth doses demonstrated that the error of the experiment did not exceed 15%. Experimental determination of depth doses is significantly less difficult than their calculation. The accuracy of the proposed method is sufficient for the calculation of doses absorbed in the irradiated tissue in roentgenotherapy and roentgenodiagnosis. (auth)

16151 RADIATION DOSIMETRY DATA CATALOGUE 1970. A Catalogue of Data Sheets Obtainable from the International Atomic Energy Agency. Vienna; International Atomic Energy Agency (1970). 84p.

Information concerning the following data is presented: general physical data; biophysical data; physical data used in clinical dosimetry; surface and internal discrete sources data; medium energy x-ray isodose charts; ^{137}Cs gamma ray isodose charts; ^{60}Co gamma ray isodose charts; high energy x-ray isodose charts; electron beam isodose charts; and moving beam dose distributions. A list of IAEA publications in dosimetry and a list of manufacturers of high energy radiotherapy equipment are appended and an index by origin of data is included. (H.L.W.)

16152 ESTIMATION OF GONADAL ABSORBED DOSE DUE TO ENVIRONMENTAL GAMMA RADIATION. Bennett, Burton G. (Atomic Energy Commission, New York). Health Phys.; 19: 757-67(Dec 1970).

Analytical transport theory was used to investigate the procedures for converting free-air exposure measurements to absorbed doses in the reproductive organs of populations exposed to various natural and fallout environmental radiation fields. Calculated air-over-ground environmental γ ray spectra for uniformly distributed ^{238}U, ^{232}Th, and ^{40}K, and ^{137}Cs plane and exponentially distributed sources in the soil are the inputs for the γ ray transport calculations in tissue slabs. Corrections are made to account for the finite width and surface curvature of the body. Anatomical drawings of actual body cross sections, showing the amount of overlying tissue and bone, are then used with these results to obtain gonadal absorbed dose estimates for uniform exposure around the body. Though results indicate that a single screening factor is valid for various environmental fields, more satisfactory gonadal dose estimates would be obtained if the 0.6 screening factor recommended in 1962 by the United Nations Scientific Committee on the Effects of Atomic Radiation were revised to 0.8. Independent experimental measurements with a realistic man phantom support these conclusions. (auth) (UK)

16153 EXPERIENCE IN AIR MONITORING OF RADIOACTIVE AEROSOLS. Koenig, L. A. (Kernforschungszentrum, Karlsruhe, Ger.). Atompraxis; 16: 320-4(Sep-Oct 1970). (In German).

Experience gained at the Karlsruhe Nuclear Research Center with respect to air monitoring of radioactive aerosols is reported. The present measuring results reveal that aerosol activity concentrations which are constant in time and space can hardly be expected for ventilated rooms. Consequently, the results of comparative measurements conducted with the same method are not in agreement which means that an agreement of measurements carried out by dissimilar techniques cannot be anticipated at all. The concentration values determined are dependent, in particular, on the period of collection and the choice of the place of collection, as well as on the movement which takes place in the monitored room. The present experience shows the relation between the quotients of aerosol activity concentration and surface contamination and the existing conditions. (auth)

16154 ENVIRONMENTAL SURVEILLANCE IN THE VICINITY OF NUCLEAR FACILITIES. Proceedings of a Symposium Held in Augusta, Georgia, January 24-26, 1968. Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970). 477p. $29.00. (CONF-680108).

Abstracts were prepared for 35 of the 47 papers in this symposium. Other papers were previously abstracted in NSA. (E.E.H.)

For abstracts of individual papers see: 16082–16084, 16155–16185, and 16207.

16155 OBJECTIVES OF ENVIRONMENTAL MONITORING IN THE VICINITY OF NUCLEAR FACILITIES IN THE UNITED KINGDOM. Dunster, H. J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 5-11 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

The basic objectives of any program for environmental monitoring of nuclear facilities are to assess the radiation hazards to man, to provide empirical data on radiation, and to improve public relations. The responsibilities of both the operating managements and the government in the U. K. in fulfilling these objectives are discussed. The importance of preoperational radiation surveys and of well defined procedures for emergency surveys is presented. In general, the British strive, through the combined efforts by operators and government agencies, to develop economically sound environmental monitoring programs which assure the public safety and which concentrate on obtaining the necessary information with minimum of sampling and analysis. (L.C.L.)

16156 OBJECTIVES OF ENVIRONMENTAL SURVEILLANCE: A CANADIAN VIEWPOINT. Mawson, C. A. (Chalk River Nuclear Labs., Ont.). pp 12-13 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

Canadian experience in monitoring environmental radioactivity caused by the disposal of radioactive wastes from a nuclear facility is discussed with particular reference to waste disposal into the Ottawa River. The monitoring results showed that waste disposal fallout in precipitation, contamination of vegetation, uptake of fission product radioisotopes into animals, fish, and insects, and contamination of local milk supplies were no higher than could be expected from nuclear weapons fallout. Therefore the level of environmental radiation monitoring activities near the nuclear facility was considerably reduced, but continues to provide information adequate for insuring the public safety. (L.C.L.)

16157 OBJECTIVES OF ENVIRONMENTAL SURVEILLANCE: THE AMERICAN VIEWPOINT. Whipple, G. H. (Univ. of Michigan, Ann Arbor). pp 14-18 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

The results of a survey of the objectives and practices of environmental surveillance conducted by the nuclear power industry are summarized. Based on the survey results, the following conclusions were drawn: all power reactor plants conduct some form of environmental surveillance; it is not clear to what extent this surveillance activity is capable of achieving the stated objectives; most of the surveillance activities are vulnerable to variations produced by nuclear detonations; and the variety of methods used for surveillance implies confusion and uncertainty. (E.R B.)

16158 OBJECTIVES OF ENVIRONMENTAL SURVEILLANCE: PANEL DISCUSSION. pp 21-5 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

A panel discussion is presented on the objectives, methods, technology, and current inadequacies of environmental surveillance programs around nuclear power plants. It was agreed that the general nature of the environment and the use to which the environment is put influences to a large degree the sophistication of the monitoring methods and the technology. Increased efficiency in effluent monitoring at nuclear power plants could conceivably eliminate the need for environmental surveillance. (E.R.B.)

16159 ENVIRONMENTAL RADIATION SURVEILLANCE: A COMPARISON OF THE RECOMMENDATIONS OF FOUR INTERNATIONAL AGENCIES. Moeller, D. W. (Harvard Univ., Boston); Goldin, A. S.; Pavanello, R. pp 29-39 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

A comparison is made of the recommendations of four international organizations (ICRP, IAEA, FAO, and WHO) regarding environmental radiation surveillance. The views of the various organizations are given pertaining to the following specific concepts and techniques: types and objectives of environmental surveys; necessity and responsibility for surveillance; design of a survey; objectives of preoperational surveys; sampling methods and frequency; analysis of samples; and manpower, equipment, and laboratory requirements. In commenting on the recommendations of the various organizations, it was concluded that each organization represents the best source of information on some specific aspect of surveillance i.e., ICRP — philosophy and fundamental principles; WHO — detailed surveillance operations (air and water); FAO — detailed surveillance operations (milk and foods); and IAEA — up-to-date information on world wide surveillance programs. (E.R.B.)

16160 PROGRAMS FOR ENVIRONMENTAL SURVEILLANCE AROUND NUCLEAR POWER PLANTS. Brinck, W. L. (Public Health Service, Cincinnati); Harward, E. D.; Chissler, R. I. pp 46-54 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

Information on environmental surveillance programs obtained for most of the power reactors now in operation in the United States is summarized. The information includes: types of samples collected; frequency of collection; analyses performed; and similarities and differences among programs. Recommendations for surveillance made by the National Center for Radiological Health (NCRH) are reviewed and compared with current practices. The components of environmental surveillance programs around nuclear power plants are presented in tabular form. The following conclusions are suggested by the summary, although considerable variation exists among current programs, the majority of the programs are compatible with the recommendations of the NCRH; a uniform format and consistent units in reporting data are needed to enhance comparability of data among programs; and surveillance program specifications should be periodically reviewed to keep up with new technological developments and new problems. (E.R.B.)

16161 PERFORMANCE AND DESIGN OF AN ENVIRONMENTAL SURVEY. Pelletier, C. A. (Atomic Energy Commission, Idaho Falls, Idaho). pp 55-65 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

Design methods and criteria for an environmental surveillance program are presented. In relation to atmospheric releases to the terrestrial environment, the program meets the two suggested criteria i.e., identification and measurement of the radioactivity released from the facility, and provision of reasonable evidence that the facility did not release radioactivity to the environment when in fact it did not. The following technical aspects of the program are discussed: sample media; number and location of samples; and statistical manipulation of data from routine, continuous, or intermittent releases. Equations are developed in the discussion that are applicable to any atmospheric release surveillance program. (E.R.B.)

16162 COMPARISON OF THE THRESHOLD, ABSOLUTE CONTRIBUTION, AND GRADED APPROACHES TO ENVIRONMENTAL RADIOACTIVITY SITE SURVEYS. Russo, P. F.; Fix, R. C. (Div. of International Chemical and Nuclear Corp., Waltham, Mass.). pp 66-70 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

Three general approaches to environmental radioactivity site surveys are compared and the cost for typical programs based on each approach are presented. The threshold approach is designed to show that radioactivity levels are below the thresholds established during the design phase. No attempt is made to determine how far below these levels the actual level is. The absolute contribution approach determines the actual levels generally by using more sophisticated analytical techniques. The graded approach varies the intensity of the program according to observed plant operating conditions. The information provided by programs based on each approach and their inherent limitations are discussed. The total costs for a 2 yr preoperation phase and for the first and succeeding years of the operating phase of programs based on each

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approach are presented and compared in tabular form. Monitoring programs based on each of the three approaches or on a combination of elements of the three have been acceptable to the various regulatory agencies. Most nuclear facilities have to date used essentially the threshold approach combined with limited specific nuclide analysis in their programs. As a result of the rapid increase in the number of multiple source situations, the use of the absolute contribution approach to program development seems to be a certain requirement. (E.R.B.)

16163 APPLIED ECOLOGICAL STUDIES ON THE ENVIRONMENT OF THE CASACCIA NUCLEAR CENTER (ROME, ITALY). Rossi, L. C.; Cigna, A. A.; Giorcelli, F. G.; Nardi, A. (CNEN, Rome). pp 71-6 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

Under current operating conditions, the ^{90}Sr output by the Casaccia Nuclear Center near Rome, Italy is less than 10% of that allowed by the provisional discharge guide (50mCi/yr). In view of the development of new facilities at the center necessitating a higher discharge rate, ecological studies were conducted in the surrounding environment to determine the maximum rate of discharge of radionuclides, the critical population group, and the critical crops. These parameters are identified and discussed, and the derived working limits (DWL) (pCi/l in river water at the point of discharge) are calculated for ^{65}Zn, ^{90}Sr, ^{106}Ru, ^{137}Cs, and ^{144}Ce. (E.R.B.)

16164 DESIGN OF A PREOPERATIONAL ENVIRONMENTAL SURVEY FOR THE NUCLEAR CENTER IN MEXICO. De Nulman, R. M.; Burillo, G. (Comision Nacional de Energie Nuclear, Mexico City). pp 77-83 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

The design of a preoperational survey for the Nuclear Center in Mexico is described. The purpose of the survey is to produce base-line data to enable the detection of future increases in radioactivity so that adequate measures can be taken to prevent health hazards, and to protect the Nuclear Energy Commission of Mexico from legal action resulting from alleged environmental contamination. The survey takes into consideration meteorological data and population and economic activities in an area with a 30 km radius surrounding the proposed center. Details regarding the locations of sampling stations, sampling frequency, and types of samples collected are given. It was concluded, following statistical analyses of the data obtained, that more data must be collected before the reactor becomes critical in order to design an adequate operational environmental survey. (E.R.B.)

16165 ECONOMIC PLANNING OF ENVIRONMENTAL SURVEYS FOR POWER REACTORS. Bhat, I. S. (Tarapur Atomic Power Project, India); Khan, A. A.; Kamath, P. R. pp 84-92 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

Environmental monitoring and related scientific investigations near large nuclear installations for assessment and control of exposures of the public to radioactive releases from the operations are often made by the users themselves. The argument against such surveys by proponents of cheap power is that these add to the cost of power production. Preoperational surveys at the Tarapur, India, nuclear power station site during the last 3 yrs. have shown that if the surveys are properly planned, environmental information can be gathered with little additional cost. Information was collected and reported on base-line data for natural and fallout activity levels and trace element concentrations in environment samples, population habits, critical pathways and concentrating systems, and permanent monitoring stations on the basis of land utilization and meteorology. Cost of equipping the laboratory was $64,000 and the average annual expenditure for operations and staff was $10,075 which was about 0.07% of the cost of the reactors. (E.E.H.)

16166 ENVIRONMENTAL SURVEY FOR THE NINE MILE POINT POWER REACTOR. Philbin, T. W. (Niagara Mohawk Power Corp., Buffalo); Whipple, G. H. pp 93-104 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

A graded environmental monitoring program has been proposed for the Nine Mile Point Nuclear Station. The grades in this program represent various degrees of monitoring activities and are based on the level of radioactivity discharges. Design criteria and functional specifications of the program are discussed. (E.E.H.)

16167 ENVIRONMENTAL CONTROL, A CRITICAL REVIEW OF ITS MEANS AND PURPOSES. Bergstroem, S. O. W. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 105-17 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

Nuclear energy has shown that proper safe design and planning of operations is the overall cheapest way to run an installation. Applied to environmental control, this should mean more emphasis is put on the containment of waste and the purification and control of waste flows, than on determining the environmental effects of maximum permissible releases. It was recommended that no preoperational surveys be made without a rational motive, more fundamental data on biological and geophysical mechanisms in the biosphere relevant to release calculations, environmental surveillance related to actual releases, methods and plans for emergency environmental control for all nuclear sites, and research and development on environmental control be kept separate from actual control programs. (E.E.H.)

16168 ENVIRONMENTAL MONITORING OF FISSION PRODUCT RELEASE FROM THE LOSS-OF-FLUID TEST. Wenzel, D. R. (Phillips Petroleum Co., Idaho Falls, Idaho). pp 118-28 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

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The Loss of Fluid Test (LOFT) program being conducted at the NRTS will test the ability of engineered safety systems to arrest or mitigate the consequences of a loss-of-coolant accident. It is anticipated that the containment vessel will prevent the release of nonvolatile fission products. The LOFT environmental monitoring program is concerned primarily with the monitoring of iodines, noble gases, and the daughters of noble gases. A basic design requirement of the LOFT radiological grid was to establish a monitoring program that would impose a minimum of constraints on the tests while effectively monitoring the initial fission products released to the environment. The conclusions established in the design of the radiological grid are given. (E.E.H.)

16169 NEW JERSEY'S DEVELOPMENT OF A COMPREHENSIVE ENVIRONMENTAL SURVEILLANCE PROGRAM. Amato, C. G.; Aaroe, W. H.; Halperin, E.; Boros, L. (New Jersey Dept. of Health, Trenton). pp 129-35 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

The present and future environmental monitoring program within New Jersey, as one of many conducted by the State Radiological Health Program, is discussed. The program maintains and staffs its own laboratories, and all operations are conducted from Trenton, New Jersey. Full responsibility for the Radiological Health Program is vested in the state. Functionally, a State Police Operations Order has evolved for handling all radiation emergencies, including off-site nuclear reactor releases. The objectives and purposes of the state program are stated and discussed in relation to cost. (E.E.H.)

16170 NEED FOR PREOPERATIONAL METEOROLOGICAL PROGRAMS FOR NUCLEAR REACTOR SITES FOR THE ELECTRIC POWER INDUSTRY. Courtney, F. E. Jr. (Dames and Moore, Atlanta). pp 140-7 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

In considering all factors that enter into nuclear site safety calculations, one of the most important things to be considered is on-site meteorology. On-site observations are valuable evidence of what the atmosphere can provide in the way of dilution potential. Such a survey can provide information on minimal atmospheric dilution during a temperature inversion in the lower layers, on wind directions and frequency, and on precipitation. In order to understand the diffusion characteristics of the site selected, the

survey should also provide information on the shape and location of the terrain selected. (E.E.H.)

16171 ENVIRONMENTAL MONITORING IN EMERGENCIES. Howells, H. (United Kingdom Atomic Energy Authority, Windscale, Eng.); Dunster, H. J. pp 151-61 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

The planning of procedures for dealing with an off-site emergency must be a compromise between detailed planning aimed at eliminating unnecessary delays at the time of the emergency and the flexibility needed to cope with the unforeseen. In planning an emergency environmental monitoring program, certain basic requirements are guides applicable to environmental contamination in the event of release of radioactive materials, monitoring measurements that provide information directly related to the guide levels, analysis of accident potential of the site, adequate facilities for the larger possible accidents, assessment of the immediate potential hazard from inhalation or external irradiation, and rapid determination of the contamination of food and drinking water. Current procedures at the Windscale and Calder Works of the United Kingdom Atomic Energy Authority are described and discussed. (E.E.H.)

16172 GUIDES FOR PREDICTING THYROID DOSE FROM ENVIRONMENTAL MEASUREMENTS FOLLOWING RADIOIODINE RELEASES. Peterson, H. T. Jr.; Smith, J. M. (National Center for Radiological Health, Rockville, Md.). pp 172-88 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

A prompt assessment of the expected thyroid dose is required in order to evaluate the need for protective action following accidental releases of radioiodine from nuclear facilities. Factors required in making this assessment from measurements of environmental contamination are considered. The derived values generally do not apply under conditions of continuing radioiodine buildup. Furthermore, the dose estimate becomes more inexact the farther up the milk ingestion chain the measurement is made due to assumptions required to estimate the contamination of one section of the chain from measurements made in the preceding section. The consequences of such errors are discussed. (E.E.H.)

16173 EXPOSURE TO RADIATION FROM GAMMA-EMITTING FISSION-PRODUCT RADIONUCLIDES IN ESTUARINE SEDIMENTS FROM THE NORTHEAST IRISH SEA. Jefferies, D. F. (Fisheries and Food Fisheries Radiological Lab., Lowestoft, Eng.). pp 205-16 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

The composition of low-activity radioactive wastes discharged into the Irish Sea from the premises of the United Kingdom Atomic Energy Authority, Windscale, Cumberland has shown a slight decrease in ^{106}Ru and a sharp increase in ^{95}Zr and ^{95}Nb due to the introduction of a new fuel reprocessing plant in 1964. The importance of these latter two radionuclides in the Windscale environment lies in their potential contribution to the external γ dose. Since January 1965, the external radiation exposure to the public using the beaches in the area has been examined in some detail, including measurements of the external γ dose rate over beach sand, mud flats, and mussel beds in the intertidal zone, radiometric analysis of silt and other samples, and habits surveys to establish the relevant occupancy factors in the areas of most concern. Data are delineated and discussed in relation to ICRP-recommended dose limits. (E.E.H.)

16174 APPROACH FOR ASSESSING POTENTIAL POPULATION EXPOSURES. Rohwer, P. S.; Cowser, K. E.; Snyder, W. S.; Struxness, E. G. (Oak Ridge National Lab., Tenn.). pp 217-25 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

Techniques for estimating the doses received by populations living in environments subject to low levels of contamination are being developed as part of a general program in the Health Physics Division at Oak Ridge National Laboratory. Models are being developed to estimate total radiation doses received by individuals whose habits and characteristics may be changing throughout the exposure period. Steps for application of these models to provide projected dose estimates in potential population exposure situations were formulated. The degree of precision in the dose estimates will be limited by the data describing the initial distribution of radioactivity, the environment, and the population. The radiation safety criteria to be used in assessing the dose estimates that result from applications of these generalized models are clearly established for peacetime applications of nuclear energy. (E.E.H.)

16175 RADIONUCLIDE RELEASES AT NUCLEAR POWER STATIONS. Brinck, W. L.; Kahn, B. (Public Health Service, Cincinnati). pp 226-33 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

Knowledge of radioactivity released under normal operating conditions by nuclear powered electrical generating stations is fundamental to planning environmental surveillance. Information on radionuclide releases from eight operating reactors was obtained. All gross activity values were converted to annual totals and average rates or concentrations for each calendar year. For liquid wastes, releases were calculated at total curies; for waste from the stack, as average release rates; and for solids, as total curies. For surveillance purposes, measurement of individual radionuclides is especially important. The compilation indicated consistently increasing values with operating time, but shows ranges of many orders of magnitude for annual releases and average rates. It was suggested that radionuclide release data be considered an integral part of environmental surveillance. (E.E.H.)

16176 COMPARISON OF CALCULATED AND MEASURED LONG TERM GAMMA DOSES FROM A STACK EFFLUENT OF RADIOACTIVE GASES. May, M. J.; Stuart, I. F. (General Electric Co., San Jose, Calif.). pp 234-48 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities. Augusta, Ga. See CONF-680108.

A method is presented for calculating the γ dose to the surrounding environment from radioactive material normally released in the exhaust of a nuclear power plant during operation. Calculated values are then compared with measurements made at the Brookhaven Graphite Research Reactor. From the data presented, it was concluded that the analytical model provided a good correlation between stack release rate and ground level γ dose. Reactor operation and release rates were sufficiently uniform to ignore seasonal variations. (E.E.H.)

16177 INVESTIGATION OF RADIOACTIVE DUST DISPERSED FROM URANIUM TAILINGS PILES. Breslin, A. J.; Glauberman, H. (Atomic Energy Commission, New York). pp 249-53 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

An investigation was made of the possible hazards of radioactive dust dispersed from uranium tailing piles near inactive ore mills. Measurements were taken in relation to wind dispersal and the distance from the piles. At two mills, inhalation exposures were trivial; at a third, hypothetical exposures did not exceed maximum permissible concentrations except, possibly, within the shadow of the tailing piles. The reported values are not considered to be better than approximations of average exposures. (E.E.H.)

16178 EVALUATION OF FISSION PRODUCT AND ACTIVATION ISOTOPES IN A REACTOR STACK EFFLUENT AND IN THE NEARBY ENVIRONMENT. Hull, A. P.; Gilmartin, J. T.; Smith, M. E. (Brookhaven National Lab., Upton, N. Y.). pp 285-93 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

A study was made of the γ emitting isotopes present in concentrations greater than 1.0 pCi/m in the stack effluent of air-cooled graphite-moderated research reactor for one yr. For the first three months a May-Pak sampler was employed; a conventional particulate and charcoal filter was employed for the balance of the year. The only short-lived isotopes detected were ^{82}Br and ^{133}I. Most of the effluent radioiodine was in states other than methyl iodide. The intermediate and longer lived isotopes detected included both activation and fission products. Among the activation

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products, ^{203}Hg was present in the greatest concentration; among the fission products, ^{131}I. Ground level air concentrations of ^{82}Br and ^{133}I were tested in three separate one day samples. The amounts were less than those calculated from meteorological dispersion considerations. (E.E.H.)

16179 SURVEILLANCE TECHNIQUE FOR TRITIATED MOISTURE IN THE ATMOSPHERE. Sax, N. I.; Gaby, J. J. (New York State Dept. of Health, Albany). pp 382-7 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

Tritium, when released to the atmosphere, will rapidly exchange with any H_2 available, i.e., H_2O (vapor), H_2, and CH_4. Since H_2 and CH_4 are trace components, sampling of H_2O vapor represents the best method of assessing atmospheric ^3H contamination. A simple and inexpensive atmospheric moisture sampler has been developed for field use. It consists of indicating silica gel (approximately 200 gm) in a bag made of fiberglass screening suspended approximately 6 ft off the ground. (E.E.H.)

16180 ENVIRONMENTAL MONITORING SIGNIFICANCE OF THE CLINCH RIVER STUDY. Abee, H. H.; Cottrell, W. D.; Cowser, K. E.; Nelson, D. J. (Oak Ridge National Lab., Tenn.). pp 388-93 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

A study was conducted over a 5-yr period (1960 to 1964) to obtain fundamental information on physical, chemical, and biological dynamics of the Clinch River associated with discharges of low-level radioactive wastes from atomic energy installations at Oak Ridge. The general objectives of the study were to determine the fate of radioactive materials being discharged to the Clinch River, to investigate dispersal mechanisms, evaluate radiation safety, evaluate the limitations for receiving radioactive effluents safely, and to suggest long-term monitoring procedures. A summary of findings, including current data that relate to the potentially critical population exposure pathways, is presented. (E.E.H.)

16181 IMPROVED COMPUTER PROGRAM FOR ACCURATELY PREDICTING THE CONSEQUENCES OF RADIOACTIVE ENVIRONMENTAL RELEASES. Ruhter, P. E. (Atomic Energy Commission, Idaho Falls, Idaho); Fielding, J. R. pp 394-9 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

The RSAC computer program was developed to calculate potential radiological hazards from the release of fission products to the atmosphere. The program was initially written in Symbolic Language (MAP) for the IBM 7040 computer, but is presently being rewritten in Fortran IV language so that it will also be compatible with the IBM 7044 computer. A number of important changes have been developed to increase its versatility and accuracy. The overall capabilities of the RSAC program and the recent changes are discussed. A comparison is made between the expected doses as calculated and those doses actually experienced from planned radiological releases that have occurred at the NRTS. (E.E.H.)

16182 ON-LINE COMPUTER FACILITY FOR SOLID STATE/NaI, SINGLE/DUAL PARAMETER GAMMA ANALYSIS FOR LOW LEVEL SAMPLES: HARDWARE. Coats, G. I.; Nelson, C. B.; Friend, A. G. (Northeastern Radiological Health Lab., Winchester, Mass.). pp 400-9 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

In monitoring around nuclear facilities, great sensitivity is required for preoperational surveys and greater resolution is required for postoperational monitoring. Gamma spectrometry using multiple NaI detectors with coincidence techniques or using high resolution solid state detectors has been developed. Low cost on-line computers, functioning as multichannel analyzers, offer possibilities for improved data handling for these detectors. Data acquisition, data reduction, and data output for the NERHL on-line computer are discussed. (E.E.H.)

16183 SOLID STATE/NaI, SINGLE/DUAL PARAMETER GAMMA ANALYSIS FOR LOW LEVEL SAMPLES USING AN ON-LINE COMPUTER: RESULTS. Lutz, J. D.; Ham, R. B.; Friend, A. G. (Northeastern Radiological Health Lab., Winchester, Mass.). pp 410-18 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

The operation of an integrated counting room for solid state NaI, single/dual parameter analysis for low-level samples using a single on-line computer accepting data from several detector systems is discussed. Input signals originate with a multiparameter system: a 40-cc Ge(Li) detector and a 200-mm × 3-mm Si(Li) detector. The combination of a small digital computer interfaced to flexible detector systems has provided an extremely versatile system for environmental radioassay. The inherently low counting efficiency of the detector arrays is more than offset by their selectivity. It is felt that the cost of a general-purpose computer is well justified by its ability to do general data reduction and computation in addition to data acquisition. (E.E.H.)

16184 ASSESSMENT OF RADIOACTIVE CONTAMINATION IN THE ENVIRONMENT BY FIELD GAMMA SPECTROMETRY. Lowder, W. M.; Beck, H. L.; McLaughlin, J. E. (Atomic Energy Commission, New York). pp 419-25 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

The utility of standard techniques of γ ray detection for environmental surveillance around nuclear facilities has been well established. Consideration of the possible value of taking a laboratory scintillation spectrometer to the field and conducting a γ spectrometric analysis of the radiation in situ is proposed. The main utility of field γ spectrometry under emergency conditions would be two-fold; to provide a check on other methods of estimating the deposition and/or dose rates and to permit a reliable assessment of the hazard in particularly critical areas such as population centers and pasture lands. Techniques for field spectrometry are discussed. (E.E.H.)

16185 RADIOACTIVITY IN COAL MINE DRAINAGE. Caldwell, R. D.; Crosby, R. F.; Lockard, M. P. (Nuclear Materials and Equipment Corp., Apollo, Pa.). pp 438-45 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

Natural radioactivity in the Kiskiminetas River in western Pennsylvania was investigated. A survey of the Kiski area resulted in the discovery that coal mine drainage from strip and deep mines was responsible. Uranium in the coal and shale overcover, exposed to weathering and ground water during mining, is leached out and deposited downstream. The radioactivity was predominantly from ^{234}U and ^{238}U; less than 10% was from ^{226}Ra. Subsequently, the Susquehanna River was also surveyed and the results are reported. It was recommended that nuclear facilities located in coal mining areas sample above and below their discharge points in receiving streams in order to determine actual plant releases of radioactive effluents. (E.E.H.)

16186 EVALUATION OF CHANGES IN PERCENTAGES OF DEPTH DOSE FOR RADIOTHERAPY. Janaky, Gyula. Magy. Radiol.; 22: 101-8(Apr 1970). (In Hungarian).

Methods for the measurement of the percentage of depth dose for x radiotherapy are discussed. In the case of identical tension or field size the curves cross each other always at a depth of 4 cm. The beginning curves of the change of the depth dose show always an upward elevation, and after the rise of the tension, as well as simultaneously with the increase of the field size, the starting points of the curves are displaced deeper and deeper. The findings are illustrated with graphs. (auth)

16187 ^{137}Cs LEVELS IN HUMAN ADULT POPULATION IN CALIFORNIA, 1960 TO 69. MacDonald, N. S.; Ban, I.; Fleeher, A.; Hackendorf, M. (Univ. of California, Los Angeles). Nature (London); 228: 283-4(17 Oct 1970).

The results of 1052 measurements of ^{137}Cs levels in 454 persons during the decade 1960 to 69 are reported. The measurements, together with those for naturally occurring ^{40}K, were made by gamma spectroscopy using a whole-body counter consisting of four NaI scintillation detectors and a multichannel pulse height analysis system. The trend of values is shown graphically as pCi of ^{137}Cs per g of K. It was found that the peak of contamination during 1964 to 1965 occurred 12 to 15 months after cessation of atmospheric testing of nuclear devices by the USA and the Soviet Union. Subse-

quent French testing programs have not reversed the downward trend since 1965, but have significantly slowed the rate of decrease, and this more recent injection of ^{137}Cs into the environment is also shown graphically. A consistently higher ^{137}Cs concentration was found in men as compared to women. Concentrations of ^{137}Cs in diet are also shown and the dietary $^{137}Cs/K$ ratios were about three times less than in the human subjects. The calculated absorbed doses to total body, to marrow, and to the gonads were between 8 and 10 mR for the 10-yr period, as compared with 156 mR for natural ^{40}K. (UK)

16188 ENERGY AND L.E.T. SPECTRA OF CYCLOTRON BEAMS: PREDICTION AND MEASUREMENT. Maccabee, Howard D. (Medical Research Council Radiobiological Research Unit, Harwell, Eng.). pp 183-93 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons ... Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The straggling theories involved in predicting the particle energy spectrum of an accelerator beam after slowing down in a thin or thick absorber are reviewed briefly. Semiconductor detectors have been used to measure energy loss distribution and residual energy distribution for many accelerator beams. The measured energy loss spectrum of a 45.3 MeV proton beam in a thin silicon absorber, and the residual energy spectra of beams of 19.68 MeV protons and 79.8 MeV He^{+2} ions slowing down in thick aluminium absorbers are presented. In these and other cases, the measured distributions are in good agreement with the theoretical predictions of Vavilov for thin absorbers, and with those of Tschalär for thick absorbers. A computer code for predicting L.E.T. distributions of heavy charged-particle beams slowing down in matter was developed, and the calculated L.E.T. spectrum is given for an experiment in which 14.5 MeV protons were slowed to 12% of their initial energy. The implications are discussed for experiments in which degrading absorbers are used to increase the L.E.T. of an accelerator beam by reducing its energy. In extreme cases the usefulness of the concept of an "average" L.E.T. is vitiated by the severe skewness of the L.E.T. distribution due to straggling. (auth) (UK)

16189 IMPORTANCE OF HEMATOLOGIC EXAMINATIONS IN THE ASSESSMENT OF THE CHRONIC LOW-DOSE RADIATION LOAD OF RADIOLOGISTS. Mozsa, Szabolcs. Magy. Radiol.; 22: 109-16(Apr 1970). (In Hungarian)

The use of hematologic data as a biological indicator of radiation injury of personnel exposed to chronic, low-dose ionizing radiations is discussed. Data on the shortening of the life span and leukemia incidence in radiologists are reviewed as examples of the pathological effects of chronic low-dose exposure. The need for radiation protection of personnel and the general population is discussed. The need for research to establish accurate relations between radiation dose and hematologic findings for use in dosimetry is discussed. (C.H.)

16190 DEPENDENCE OF EXPOSURE RATE UPON FIELD SIZE AND SHAPE. Herbert, D. (Penrose Cancer Hospital, Colorado Springs). Brit. J. Radiol.; 44: 75(Jan 1971).

Observations of a Theratron 80 are summarized by the following equations: (1) $Y = 0.951 + 0.433^* [X^*(1 - X) - 0.103]$, (for 100 kVp 0.25 mm Cu HVL, 100 kVp 1.00 mm Al HVL, 140 kVp 0.50 mm Cu HVL); (2) $Y = 0.944 + 0.547^* [X^*(1 - X) - 0.103]$, (for 300 kVp 2.00 mm Cu HVL, 300 kVp 3.00 mm Cu HVL). $X = \log_{10} (A/P)$, A being the area, P being the perimeter of the field. Y is the exposure rate in R/minute, normalized to a 10×10 cm^2 field. (UK)

16191 DEPTH DOSE AND QUALITY FACTOR FOR NEUTRONS IN RADIATION PROTECTION. Wagner, S. (Physikalisch-Technische Bundesanstalt, Brunswick). Atomkernenergie; 16: 243-6(1970).

The depth dose calculations for monoenergetic neutrons start from different assumptions on the phantom and on the irradiation conditions. The resulting maximum equivalent doses and effective quality factors are collated and discussed. There are considerable differences in both quantities. For radiation protection purposes an upper limit of the maximum equivalent dose is obtained by using the results of the calculations for the slab phantom with normally incident neutrons. Measuring devices, the indication of which is proportional to the maximum equivalent dose as obtained in these calculations should not be required to provide a smaller uncertainty than about ±50%. (auth)

16192 RADIOLOGIC STUDY OF INORGANIC URINARY CALCULI. I. COMPARISON OF STABLE AND RADIOACTIVE STRONTIUM DEPOSITION IN URINARY CALCULI AND HUMAN BONE. Herring, Louis C.; Keefer, Douglas H. (Louis C. Herring and Co., Orlando, Fla.). Arch. Environ. Health; 22: 239-50(Feb 1971).

The radiological surveillance of large numbers of inorganic urinary calculi surgically removed from urolithiasis patients may provide a method for estimating the radiation dose of the general population resulting from internally deposited ^{90}Sr. Fifty thousand inorganic urinary calculi were assayed for stable and radioactive strontium and correlated with strontium deposition in human bone data collected during the same period. The relation between the average ^{90}Sr data for urinary calculi and those reported for human bone samples indicate that this routinely available source of internal assay material could provide a cursory estimation of regional or national population body burdens and doses resulting from ^{90}Sr in human bone. No evidence was found that the current concentration of ^{90}Sr in urinary calculi creates a harmful internal radiation dose. (auth)

Radiation Protection

Refer also to abstract 16275.

16193 (BRH/OBD-70-2) UNIVERSITY CURRICULUMS AND FELLOWSHIPS IN RADIOLOGICAL HEALTH. (Bureau of Radiological Health, Rockville, Md.). [nd]. 86p.

The colleges and universities included in this publication offer academic programs in radiological health that are funded in part by the Radiological Health Training Grants Program of the Bureau of Radiological Health. The academic programs offered by the institutions are on the graduate level (Radiological Health Specialist) and the undergraduate level (Radiological Health Technician). The degrees offered, prerequisites for entry, curriculum, and objectives in the programs of each of the 35 participating institutions are presented. (E.R.B.)

16194 (BRH/OBD-70-3) 1969 ANNUAL REPORT TO THE CONGRESS ON THE ADMINISTRATION OF THE RADIATION CONTROL FOR HEALTH AND SAFETY ACT OF 1969, PUBLIC LAW 90-602. (Bureau of Radiological Health, Rockville, Md.). 1 Apr 1970. 95p. NTIS.

This annual report contains: a thorough appraisal of the incidence of biological injury and effects, including genetic effects, to the population; a list of Federal electronic product radiation control standards; an evaluation of the degree of observance of applicable standards; a summary of outstanding problems in the administration of the Act; an analysis and evaluation of research activities and technological progress for safety; a list of completed or pending judicial actions; the extent to which technical and consumer-oriented information was disseminated; and the extent of cooperation between Government officials and representatives of industry and other interested parties. The report also contains such recommendations for additional legislation as the Secretary deems necessary to promote cooperation among the several States in the improvement of electronic product radiation control and to strengthen the national electronic product radiation control program. (auth)

16195 (CEA-Bib-179) OXIDATION OF TRITIUM TO TRITIATED WATER AND HEALTH PHYSICS. Ballereau, Pierre (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Nov 1970. 65p. Dep. NTIS (U. S. Sales Only).

Tritium can be present in various forms in laboratories: gaseous tritium, organic compounds, tritiated water. Tritiated water is the most hazardous form of tritium. In presence of air, tritium and its compounds can be converted into oxide by two independent reactions; self-oxidation by β radiation and isotopic exchange between gaseous ^3H and the ^1H atoms of water vapor. The determination of the rate constants of the conversion of tritium into tritiated water is necessary to ensure the protection of workers in a tritiated environment. (73 references were reviewed.) (France)

16196 (JPRS-52121, pp 25-9) EFFECTIVENESS OF SHIELDING DIFFERENT BODY PARTS DURING REPEATED PROTON IRRADIATION. Nevskaya, G. F.; Abramova, G. M.; Ginsburg, E. V.; Kalandarova, M. P. Translated from Kosm. Biol. Med.; 4: No. 5, 20-3(1970).

Dogs were exposed to proton irradiation (700 Rad, two exposures of 350 Rad each at 45-day intervals). The pelvic zone and upper portion of the abdomen, constituting 15% of the total body weight, were exposed. The protective effect was found to be related to the extent of the undamaged portion of the bone marrow. This amounted to 15% and 5% of the total bone marrow in the dog skeleton when the pelvis and abdomen respectively were shielded. During single

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or repeated irradiations with the minimum absolutely lethal doses, shielding of 5% of the bone marrow failed to repair hemopoiesis to a sufficient degree and the changes in the tested parameters were greater than in animals with 15% of the bone marrow shielded. These changes were manifested not so much in hemopoiesis inhibition as in the rate and degree of bone marrow repair and the level of restoration of blood indices. (auth)

16197 (NCRP–37) PRECAUTIONS IN THE MANAGEMENT OF PATIENTS WHO HAVE RECEIVED THERAPEUTIC AMOUNTS OF RADIONUCLIDES. (National Council on Radiation Protection and Measurements, Washington, D. C.). 1 Oct 1970. 61p. NCRP Publications, Washington, D. C. $1.50.

Information of use to persons caring for or associated with patients who have received therapeutic doses of radionuclides or doses in the millicurie range for diagnostic purposes is presented. Emphasis is placed on the determination and use of exposure rate for decisions with respect to protective procedures. Four situations are considered in detail: patients receiving regular nursing care in the hospital; patients referred for emergency surgery; patients released from the hospital while still containing an appreciable quantity of the radionuclide; and patients who die while appreciably radioactive. Recommendations regarding the radioactive patient, necessary to meet accepted standards of protection, and advisory recommendations, applied in the interest of minimizing radiation exposure, are given. (E.R.B.)

16198 (RPS-AR–3) ANNUAL REPORT FOR THE YEAR 1969. (Ministry of Public Health, Bangkok (Thailand). Radiation Protection Service). 23p. Dep. NTIS (U. S. Sales Only).

Matters concerned with radiation protection and calibration arising from uses of x rays were delegated by the A.E.C.P. through its subcommittee on radiation protection to the Department of Medical Sciences. The World Health Organization is assisting the program by providing short-term consultants drawn from the senior staff of the National Radiation Laboratory for annual assignments of two months each. Progress is reported on radiation calibration and protection surveys in radiotherapy departments and radiation protection surveys in diagnostic x-ray installations, in clinical usage of sealed radium sources, and in industrial, experimental and research uses of x-ray machines. Progress is reported on activities of the radiation monitoring film service. Lists are presented of courses and conferences attended by the Radiation Protection Service staff and lectures given by the staff. (H.L.W.)

16199 HAZARD CONTROL FOR HELIUM-NEON GAS LASERS. Oliver, R. (Oxford Univ.). Brit. J. Radiol.; 43: 909-10(Dec 1970).

The hazards of He–Ne gas lasers operating in the range 0.5 to 50 mW are discussed. In the U.K. Code of Practice prepared by the Ministry of Technology, a limit of 0.3 $\mu W/cm^2$ is quoted for safe continuous viewing and a level of 125 $\mu W/cm^2$ is acceptable for occasional accidental exposure. With a diffuse reflection the limit for continuous safe viewing is $1 W/cm^2$ incident on the screen, and may be 20 times this figure for occasional exposure. The laser beam itself and its specular reflection from apparently rough surfaces produce a hazard of occasional exposure unless the beam power is less than 125 $\mu W/cm^2$. (UK)

16200 PROTECTION AGAINST IONIZING RADIATION FROM EXTERNAL SOURCES. A Report of ICRP Committee 3. Radiation Protection. ICRP Publication 15. Oxford; Pergamon Press (1970). 40p. 35s.

The subject is considered under the following headings: Quantities and units; absorbed dose, exposure and dose equivalent, modifying factors, determination of dose equivalent, derivation of dose equivalent from particle fluence. Recommendation on design and operation; general recommendations, medical uses of radiation, veterinary uses of radiation, industrial uses of radiation, research uses of radiation, use of radiation in education, miscellaneous sources and uses of radiation, radiation as an unwanted by-product. Survey and monitoring; general requirements, monitoring, and record keeping. 20 references. (UK)

16201 PROTECTION OF THE PATIENT IN X-RAY DIAGNOSIS. A Report Prepared by a Task Group of Committee 3 of the International Commission on Radiological Protection. Radiation Protection. ICRP Publication 16. Oxford; Pergamon Press (1970). 50p.

The subject is discussed under the following headings: The role of education in protection of the patient. General information; basic physical and biological concepts, radiation exposure from diagnostic x-ray procedures. Clinical and administrative aspects in protection of the patient; clinical judgement, administrative measures. Technical and physical factors in protection of the patient; general introduction, properties of the radiation beam, size and position of x-ray beam, shielding, grids, sensitivity of the recording system, processing techniques, control and recording of radiation exposure, reduction in number of retakes, and special types of examination. 52 references. (UK)

Safety Procedures

16202 (BRH/DEP–70-28) PRESENT FEDERAL CONTROL OF HEALTH HAZARDS FROM ELECTRONIC PRODUCT RADIATION AND OTHER TYPES OF IONIZING RADIATION (AS OF NOVEMBER 1969). (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Nov 1970. 208p. NTIS.

The results of a survey that was performed during the period from June to October 1969 to investigate the various facets of Federal radiation control are documented. The items investigated included statutory control authority, control programs and procedures, and the quantities and types of radiation-emitting electronic products and radioactive materials used by the Federal government. Thirty-three selected departments and agencies were asked to answer specific questions relating to their programs for controlling radiation from electronic products and radioactive materials. Their responses are summarized and discussed. (auth)

16203 (JAERI-Memo–4112) HEALTH AND SAFETY AT OARAI RESEARCH ESTABLISHMENT. Quarterly Report, April 1–June 30, 1970. (Japan Atomic Energy Research Inst., Tokyo). Aug 1970. 19p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The quarterly report covers the organizational details of the health and safety protection activities at the Oarai research center, outlining also the pertinent regulations. The rules covering areas which may be exposed to radiation are given in detail. The current personnel monitoring practices and examinations are described, presenting the total exposure according to the occupation of the employee. Radioactivity monitoring records are listed for dust, exhaust gas and waste water are also given. Plans have been prepared for monitoring radioactive materials in the environment. The few radioactive contamination incidents which took place during the quarter, and the measures taken to remedy the situation, are listed. (TTT)

16204 RADIOLOGICAL PROTECTION IN THE LUMINISING INDUSTRY. Venuart, J. (Radiological Protection Service, Sutton, Eng.). Health Phys.; 19: 835-6(Dec 1970).

Reference was made to a survey of a luminous dial painting plant (Moghini et al, NSA 24: 21106) and to previous work reported by the author (NSA 21: 41415). To clarify a possible source of misunderstanding, it was reiterated that due to difficulties in biological monitoring of workers handling tritium and ^{147}Pm the use of radium might be preferred by industry but that, from considerations of irradiation of the public, the use of tritium or ^{147}Pm should be supported. The need for improved containment and handling of tritium in the luminising industry was emphasised. Attention was drawn to the continuation of bad practices in some factories although legislation was adopted. It was suggested that surveillance of workers who may be receiving excessive doses would not be necessary if appropriate and reasonable control of the factory processes was undertaken. (UK)

16205 RADIATION PROTECTION IN SCHOOLS FOR PUPILS UP TO THE AGE OF 18 YEARS. A Report by Committee 3 of the International Commission on Radiological Protection. Radiation Protection. ICRP Publication 13. Oxford; Pergamon Press (1970). 11p. 7p. 7s.

Science courses in schools now include demonstrations and experiments involving sources of ionizing radiations and the pupil exposure could contribute significantly to the population dose. This is particularly important because the exposure occurs at an early age, which means that the gonad irradiation makes a maximum contribution to the population dose. Recommendations for reduced dose limits applicable to these pupils are given. The reason for the more restrictive dose limits recommended is because of the large number of persons involved. Also included is guidance for safe working procedures with radiation sources. It is felt that this guidance will have general applicability, not only to schools but also to general science courses in universities and training colleges, irrespective of the age of the students. (UK)

16206 COMMENTARY ON LASER-INDUCED BIOLOGICAL EFFECTS AND PROTECTIVE MEASURES. Wilkening, George M.

(Bell Telephone Labs., Murry Hill, N. J.). Ann. N. Y. Acad. Sci.; 168: 621-6(Feb 1970).

Hazards of laser radiation to the eye are emphasized. A discussion is presented of the power density required to reach the threshold of retinal injury and the retinal thresholds for ruby, argon, and helium-neon systems are compared. The hazards of continuous wave systems are reviewed. A comparison is made of threshold data for laser radiation with near-infrared, far-infrared, and ultraviolet radiation. The development of the tunable laser using parametric oscillation and electrooptic materials is discussed. Approaches to laser safety including the responsibility of management, technical supervision, environmental health, safety, and medical personnel are considered. (H.L.W.)

16207 INFLUENCE OF OPERATING EXPERIENCE ON EMERGENCY PLANS TO COPE WITH INCIDENTS HAVING ENVIRONMENTAL CONSEQUENCES. Selby, J. M.; Heid, K. R. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. pp 162-5 of Environmental Surveillance in the Vicinity of Nuclear Facilities. /Reinig, William C. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1970).

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga. See CONF-680108.

Authority to operate a facility with radioactive material is contingent upon the development of thorough operating procedures which include plans for coping with a serious accident. These plans should be developed to cope with any environmental incident. The basic elements which must be considered in planning are detection, recognition, and identification of the incident, notification of personnel involved and appropriate emergency personnel, evacuation of the affected area, stabilization and control of the incident and resulting contamination, investigation, and reporting. The plans themselves should be flexible but simple enough to be understood by all personnel. They should be reviewed at least once a year and whenever there is any change in operations. Modifications of the plans should be thoroughly reviewed with all personnel involved. Necessary prearrangements should be made to permit rapid release of information concerning the incident. It is also desirable to have notification for all incidents channeled through a single individual. (E.E.H.)

Legal Aspects

Refer also to abstract 16394.

16208 (BRH/ORO-70-8) MODEL LEGISLATION FOR USERS OF IONIZING RADIATION IN THE HEALING ARTS. (Bureau of Radiological Health, Rockville, Md.). Oct 1970. 24p. NTIS.

This model legislation is intended for use by the individual States as a mechanism for establishing minimal educational and training requirements for all users of ionizing radiation in the healing arts. This model forbids a person to apply ionizing radiation to human beings unless he is certified either by being granted a certificate or permit. The major purposes of the model are to protect the public from excessive and improper radiation exposure and to encourage the establishment of an internal regulatory framework for certification of users of ionizing radiation that is consistent among the States. (auth)

16209 (CONF-691129-1) NEW JERSEY'S DEVELOPMENT OF A COMPREHENSIVE ENVIRONMENTAL SURVEILLANCE PROGRAM. Amato, C. G.; Aaroe, W. H.; Halperin, Elias; Boros, Louis (New Jersey State Dept. of Health, Trenton). 23 Nov 1970. 11p.

From 97th Annual Meeting of the American Public Health Association, Philadelphia, Pa.

The medical and industrial radiation sources in New Jersey are inventoried, and a brief history of the state's Radiological Health Program, established in 1958, is given. Of prime concern to the program is environmental monitoring. Eleven monitoring programs are currently active in the state, all operating at near capacity levels, yet these programs do not reflect the power reactor sites other than Oyster Creek. The objectives of the state's environmental program are listed. Compliance with set standards regarding environmental radiation levels is not among these objectives, this is the responsibility of the licensee. The whole Radiological Health Program in New Jersey is undergoing evaluation with the goal in mind of increasing efficiency and accuracy, and decreasing the cost of maintaining the expanding program. (E.R.B.)

16210 (EUR-4515) SYSTEM OF DECLARATION AND AUTHORIZATION TO BE APPLIED ACCORDING TO THE EURATOM RADIOPROTECTION STANDARDS TO THE MEMBER STATES OF THE COMMUNITY TO ACTIVITIES AND OPERATIONS RELATING TO NUCLEAR MATERIALS AND OTHER RADIOACTIVE SUBSTANCES. (European Communities, Luxembourg. Commission). 1970. 85p. (In several languages). Dep. NTIS (U. S. Sales Only). FB 125.-.

Within the framework of effective protection against ionizing radiation, the States responsible for health policy can only take preventive measures against radiation risks if they are familiar with the possible sources of danger. For this reason, it is essential that they should know where and in what ways radioactive substances are used, what quantities and which substances are especially used, and who is employed to use them. This is why, in all the Member States of the Community, in accordance with Article 3 of the Euratom Basic Standards, the activities and operations indicated above are subject to a system of compulsory declaration or authorization. The present publication, published in the form of recapitulatory tables, contains a comparative study of the system currently operating in the six countries of the Community. (auth)

16211 (STI/PUB-250) THE LAW AND PRACTICES OF THE INTERNATIONAL ATOMIC ENERGY AGENCY. Legal Series No. 7. Szasz, Paul C. (International Atomic Energy Agency, Vienna (Austria)). Sep 1970. 1176p. IAEA $32.00.

A history-oriented approach is taken in this discussion of the laws and practices, as they have evolved through 1966, of the International Atomic Energy Agency (IAEA). The following topics, each constituting a separate part of the document, are discussed in detail: the foundation of the agency; the structure of the agency, including discussions of the statute, membership, the general conference, the board of governors, the director general and the secretariate, the relationship among the statutory organs, and the non-statutory organs; the relationships of the agency with other international organizations, with States, and with individuals; the activities of the agency including receipt of nuclear materials, agency projects, and activities in the areas of technical assistance, research, information distribution, safeguards, health and safety, and multilateral conventions; the administration of the agency in relation to staff and to financial matters; the legal aspects of the agency — matters relating to agreements, settlement of disputes, privileges and immunities, liabilities, patents and copyrights, and the official symbols of the agency; and procedures within the agency in relation to activity and progress reports, the languages used for reporting and for publications, and the documentation used in correspondence, conferences, indexes, and administrative, political, and technical papers of the agency itself. Five annexes are included containing drafts of the IAEA statute and references to its provisions, lists of principal instruments and documents, leading States and persons, abbreviations and glossary, and literature references. (E.R.B.)

Medicine

Refer also to abstracts 15802, 15964, 16047, 16278, and 16280.

16212 (ANL-7760(Pt.1)) RADIOLOGICAL PHYSICS DIVISION ANNUAL REPORT. Radiological and Health Physics, July 1969–June 1970. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 127p. Dep. NTIS.

Separate abstracts were prepared for 7 of the 13 articles included. Six of the articles were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 15835, 15878–15880, 15946, 15947, and 15961.

Protective Substances

Refer also to abstracts 16012, 16094, 16096, 16279, 16299, 16333, 16355, 16376, and 16388.

16213 (JPRS-52121) SPACE BIOLOGY AND MEDICINE, VOL. 4, NO. 5, 1970. Translation of Kosm. Biol. Med.; 4: No. 5, 3-87 (1970). 137p. NTIS.

Separate abstracts were prepared for six of the 26 articles in this issue. Other items discuss the physiological and metabolic problems of astronauts during space flight. (E.E.H.)

For abstracts of individual papers see: 16134, 16196, 16214, 16215, 16375, and 16390.

16214 (JPRS-52121, pp 15-20) PREVENTION OF RADIATION DAMAGE DURING SPACEFLIGHT. Rogozkin, V. D.; Davydova, S. A.; Tikhomirova, M. V.; Chertkov, K. S. Translated from Kosm. Biol. Med.; 4: No. 5, 13-17(1970).

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The effectiveness of two types of radioprotectants, chemical and biological, was studied using short- and long-term irradiation of animals. Biological radioprotectants (amino acids, bacterial polysaccharides, hormones and vitamins) gave a 16 to 25% increase in the number of mice surviving after prolonged irradiation. It was concluded that biological radioprotectants may well be used during spaceflight. (auth)

16215 (JPRS-52121, pp 21-4) PROTECTION OF SPACESHIP CREW MEMBERS AGAINST RADIATION DAMAGE BY USE OF RADIOPROTECTANTS. Saksonov, P. P.; Antipov, V. V.; Davydov, B. I.; Dobrov, N. N. Translated from Kosm. Biol. Med.; 4: No. 5, 17-19(1970).

General approaches to the radiation protection of spaceship crew members by the use of various drugs were discussed. An attempt was made to extrapolate experimental data obtained on animals to humans. The validity of this extrapolation was confirmed by observations accumulated in the clinical use of radioprotectants during x ray treatment. (auth)

16216 (UCLA-12-799) DEOXYNUCLEOTIDES: MODELS FOR STUDYING MECHANISMS OF STRAND BREAKAGE IN DNA 1. PROTECTION BY SULPHYDRYL COMPOUNDS. Ward, J. F. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1970]. Contract AT(04-1)-Gen-12. 25p. Dep. NTIS.

The γ-radioinduced release of inorganic phosphate from deoxynucleotides was used as a model system for strand break production in DNA. Yields of phosphate were similar for deoxycytidylic, thymidylic, deoxyguanylic, and deoxyadenylic acid with G values of 0.3 to 0.4. The total yields of phosphate (labile + inorganic were almost independent of the presence of oxygen. Impurities can markedly increase the yield of phosphate. Cysteamine, present during the irradiation of dCMP solutions, reduced the phosphate yield in the absence of oxygen. This decrease was correlated to the repair of sugar damage by donation of a hydrogen atom from the sulphydryl compound. Other radiation modifiers, cysteine, thiolactic acid and N-ethyl maleimide also reduced the phosphate yield in the absence of oxygen. The relative rates of reaction of these radiation modifiers with the deoxyribose radicals could be compared: thiolactic acid 1.45, cysteamine 1.18, N-ethyl maleimide 1.09, and cysteine 1.00. Variation of dose rate showed that the radicals on the sugar moiety of deoxycytidylic acid decompose unimolecularly in the absence of oxygen to form a product that releases phosphate. (auth)

16217 (UR-49-1389) EVALUATION OF RADIATION DAMAGE IN MAMMALIAN CELLS DUE TO THE HYDROXYL RADICAL. Roots, Ruth (Rochester Univ., N. Y.). 1970. 133p. Dep. NTIS.

Thesis.

The main purpose of this investigation was to ascertain which of the three water radicals ($OH^{\cdot}$, $H^{\cdot}$ or e^{-}_{aq}) is primarily responsible for the indirect action in radiation damage of mammalian cells; to correlate cell sensitivity with DNA single and double strand breaks; in addition, the hydroxyl radical diffusion distance was calculated from data on cell killing as well as from studies of DNA single strand breaks and double strand cuts; further, the degree of protection offered by alcohols and sulfhydryl (R – SH) compounds against x-ray irradiation was compared; and finally, x-ray induced DNA breakage was studied with freeze-dried cells in order to compare the indirect action of DNA damage for cells in the normal aqueous state versus that of the dry state. Several alcohols, R–SH compounds and one R–S–S–R substance were selected as radiation protectors, based on their reaction rate constants with the hydroxyl radical, the hydrogen atom and the hydrated electron. Each of these radical scavengers was dissolved in phosphate buffered saline and added to pellets of sedimented L 5178Y cells nine minutes before x-ray irradiation. The criteria used to evaluate radiation damage caused by the radiolytic products of water were radiation induced cell killing and DNA breakage. The former was evaluated by colony survival and the latter was studied by the use of the alkaline and neutral sucrose gradient centrifugation techniques. In the case of DNA breakage, the data show a linear relationship between the hydroxyl radical reaction rate constants and the concentration of free radical scavenger needed for half maximum protection. This relationship cannot be demonstrated for the hydrogen atom or the hydrated electron (e^{-}_{aq}). If one assumes the potential agents for indirect radiation damage are $OH^{\cdot}$, $H^{\cdot}$ and e^{-}_{aq}, it can be concluded that the hydroxyl radical is largely responsible for the indirect action in X-ray induced DNA single strand breaks. In terms of radiation induced cell killing, results from dose response curves for cells incubated with various concentrations of an hydroxyl radical scavenger during irradiation show that 6/10 of the total radiation injury is caused by the hydroxyl radical. The percent indirect effect was evaluated to be about 65% from data on cell killing and to vary between 69% and 85% as evaluated from DNA breakage depending on total x-ray dose and on whether assays were for double or single strand breakage. When data were evaluated for correlation between x-ray induced cell killing and DNA breakage, a high radiosensitivity was shown to correspond to a high degree of either single or double strand breaks. However, this correlation could not be demonstrated to be a linear relationship at all dose ranges used in our study of DNA breakage. The hydroxyl radical diffusion distance at 37°C was calculated from cell killing data to be about 41 Å; when the diffusion length was calculated from data on DNA breakage, the value varied between about 20 and 30 Å depending on the total x-ray dose. The R–SH compounds studied showed a maximum possible protection beyond that attainable by the alcohols when DNA single strand breaks were evaluated at 10 kilorads. The results of the freeze-dry experiments did not show a decrease in DNA single strand breaks as compared to that in the wet state. The freeze-dry process did not cause breaks per se. A possible explanation for the results is offered in the discussion. (auth)

16218 EXPERIMENTALLY INDUCED RADIATION NEPHRITIS TREATED WITH PREDNISOLONE. Bargon, Gerlach; Eger, Wilhelm Jr.; Rittmeyer, Klaus (Univ., Goettingen, Ger.). Strahlentherapie; 140: 192-203(Aug 1970). (In German).

Rats received unilateral irradiation on one kidney with 100 kV x radiation with a dose of 3000 rd. The effect of prednisolone or the histological slides on the radiation-induced lesions (0.2 mg/100 g body weight every 2 days) was studied. The study was confined to animals with an intact contralateral kidney and to animals that underwent a unilateral nephrectomy 2 days prior to irradiation. The prednisolone slows down the evolution of the radiation-induced changes. The effect on the late fibrosis is particularly striking. An undesired effect is the accumulation of PAS-positive material in the tubular cells. Moreover, prednisolone seemed to inhibit regeneration of tubular epithelium after irradiation. The survival of the prednisolone-treated animals was 41.6% higher after nephrectomy than of those not treated by the steroid. Prednisolone has no influence on the survival of the animals that still have their contralateral kidney. The survival of these animals reached 100%, even without prednisolone. In all animals treated with prednisolone, a weight reduction was observed that was attributed to the protein catabolism induced by the steroid. (auth)

16219 ANTIRADIATION COMPOUNDS. XIV. DITHIOCARBAMATES OF AMINOTHIOPHENES. Foye, William O.; Mickles, James; Boyce, Gerard M. J. Pharm. Sci.; 59: 1348-50(Sep 1970).

Dithiocarbamates of 2-amino-3-cyano(or carbethoxy)-4,5-dialkylthiophenes and a corresponding furan have been obtained. Dithiocarbamate formation of 2-amino-3-cyano-4,5-diphenylfuran resulted in a conversion to the corresponding thiophene dithiocarbamate. A dithiocarbamate trithiocarbonate of 2-amino-3-carbethoxy-4-mercaptomethylthiophene was also synthesized, and ring closure of the 2-amino-3-cyanothiophenes to thiopheno[2,3-d] pyrimidines was observed. None of the compounds tested showed radiation-protective or antimalarial properties. (auth)

16220 FLUORESCEIN TEST IN POSTIRRADIATION SURGERY. A PRELIMINARY REPORT. Goode, Richard L.; Linehan, James W. (Stanford Medical Center, Calif. Palo Alto Veterans Administration Hospital, Calif.). Arch. Otolaryngol.; 91: 526-8(Jun 1970).

Five percent fluorescein was given intravenously to 20 irradiated patients on whom head and neck surgery was performed, to predict future viability of skin flaps. It appeared to be a useful adjunct in preventing later flap slough, and thus decreasing postoperative complications. (auth)

16221 PROTECTIVE ACTION OF ADENOSINE ON THE RED BLOOD CELL LIFETIME IN RABBITS IRRADIATED WITH X RAYS OR FAST NEUTRONS. Dantchev-Urbain, Monique; Dantchev, Dimitre; Benard, Henri (Academie Nationale de Medecine, Paris). Compt. Rend., Ser. D; 271: 1541-4(28 Oct 1970). (In French).

X rays and fast neutrons at moderate doses of 400 R and 400 rad, delivered to rabbits in vivo, shortened the survival time of the red blood cells by an average of seven days in 62.5% (after x rays) and 70% (after fast neutrons) of the irradiated animals. The percentages fell to 25 and 20 in rabbits treated with adenosine under the same experimental conditions. (France)

16222 EFFECT OF HYPOXIA ON THE SENSITIVITY OF THE EPITHELIAL CELLS OF THE JEJUNUM. Hornsey, Shirley (Hammersmith Hospital, London). Int. J. Radiat. Biol.; 18: 539-46(1970).

Dose–effect curves for clones arising 11 days after the irradiation of a segment of the mouse jejunum were obtained. The D_0s for animals breathing oxygen or nitrogen at the time of irradiation obtained from regression lines fitted to a common extrapolation on zero dose were 117 (105 to 130) rads and 306 (276 to 344) rads, respectively, giving an OER of 2.6. This OER was not different from the OER obtained from the $LD_{50/5}$ values (2.7). The $LD_{50/5}$ doses for animals breathing oxygen or nitrogen during irradiation both fell on the extrapolated jejunal clone dose–effect curve at the same clone/test area level, suggesting that the primary cause of animal killing within 5 days of irradiation is depletion of the stem-cell population of the small intestine. The dose–effect curve for animals breathing air and irradiated at 6 krads/min had a D_0 of 268 (218 to 342) rads, which was not different from that obtained for animals breathing nitrogen. This was due to hypoxia induced by the consumption of oxygen by radiation at the high dose-rate. At a lower dose-rate, 500 rads/min, the dose–effect curve for jejunal clones in animals irradiated while breathing air was the same as that for animals irradiated while breathing oxygen. (auth) (UK)

16223 EFFECT OF STEROIDS ON THE CYCLING OF HAEMOPOIETIC STEM CELLS. **Byron, J. W. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature (London); 228: 1204(19 Dec 1970).**

The effect of single doses of steroids on the cell cycle of haemopoietic stem cells was studied. Testosterone propionate injected 1 hr and 24 hr after 150 R whole-body x irradiation led to a more rapid recovery of the population of spleen colony forming units. (UK)

16224 EVALUATION OF SYSTEMIC ANTIFUNGAL AGENTS IN X-IRRADIATED MICE. Gordee, Robert S.; Matthews, Thomas R. (Lilly Research Labs., Indianapolis). Appl. Microbiol.; 20: 624-9(Oct 1970).

The effect of x irradiation on the survival time of animals experimentally infected with pathogenic fungi was studied, and the activity of antifungal agents in preirradiated hosts was evaluated. A 24-hr preinfection dose of x irradiation decreased the survival time of mice infected with Cryptococcus neoformans and Histoplasma capsulatum to a greater extent than Candida albicans or Blastomyces dermatitidis infections. Exposure to 400 R caused a significant reduction in the variation (S^2) survival time of C. albicans or H. capsulatum mouse infections. A single 100-mg kg dose of 5-fluorocytosine or amphotericin B administered within 24 hr postinfection significantly extended the survival time of mice infected with C. albicans. Delayed treatment with amphotericin B was effective against C. neoformans infections. Four 50-mg/kg doses of 5-fluorocytosine were more effective than a single 200-mg/kg dose against C. neoformans infections. A single dose of amphotericin B provided significant protection when administered 48 hr postinfection against B. dermatitidis in preirradiated mice. A single dose of saramycetin 48 hr postinfection was highly effective against H. capsulatum mouse infections. A 100-mg/kg dose of amphotericin B was only effective against this fungal pathogen when administered within 8 hr postinfection. In vivo activity of the antifungal agents studied was detected within 8 to 14 days. The relative in vivo activity of several antifungal agents indicated the importance of considering their individual pharmacological properties for optimum effectiveness. The experimental model used in this study should be useful for the detection and for the preclinical evaluation of new antifungal agents. (auth)

16225 MODIFYING EFFECTS OF CYSTEAMINE ON EXPERIMENTAL RADIATION LESIONS OF THE BRAIN. **Hassler, Ove (Umea Univ., Sweden). Acta Radiol., Ther., Phys., Biol.: 9: 369-78(Aug 1970).**

The modifying effect of cysteamine on experimental radiation lesions in the brain were studied in 12 mice and 20 rabbits. One cerebral hemisphere was irradiated before and the other immediately after the administration of cysteamine. The radioprotective effect of cysteamine was almost equally great in skin, vessels, and the brain parenchyma, but less than that measured in the mean lethal dose in total-body irradiation. (auth) (Sweden)

16226 EFFECT OF ESCULAMINE ON THE MEMBRANE PERMEABILITY OF NUCLEI AND MITOCHONDRIA IN IRRADIATED ANIMAL CELLS. **Gorizontova, M. P. (Moscow Inst. of Normal and Pathological Physiology). Patol. Fiziol. Eksp. Ter.: 14: No. 3, 22-4(1970). (In Russian).**

Effects of esculamine on the permeability of nuclear and mitochondria in irradiated animals were studied using 88 female rats weighing 170 g and 70 male mice weighing 20 g exposed to 1000 R (with 558 R/min dose) and 800 R (534 R/min), respectively and treated internally with five doses of esculamine for three days prior to irradiation. In the rats esculamine reduced the uptake of Mg ions (one hr and 24 hr after exposure) by the nuclei of thyroid gland. In the irradiated mice the esculamine inhibited the uptake of ^{54}Mn by the liver mitochondria. In the intact animals treated with esculamine the accumulation of ^{54}Mn by the liver mitochondria was also inhibited. Data obtained confirmed the protective properties of esculamine on the membranes of nuclei and cell mitochondria. (R.V.J.)

16227 COMPARISON OF RADIATION- AND CHEMICALLY-INDUCED DOMINANT LETHAL MUTATIONS IN MALE MICE. **Ehling, U. H. (Gesellschaft fuer Strahlenforschung, Neuherberg, Ger.). Mutat. Res.: 11: 35-44(Jan 1971).**

Ionizing radiation induced dominant lethal mutations in all spermatogenic stages. After irradiation of male mice with 200 R the yield of induced mutations in early spermatids was twice the yield in spermatozoa, late spermatids, and spermatocytes. After irradiation with 400 or 800 R the spermatocytes were the most sensitive stage for the induction of dominant lethal mutations. The frequency of radioinduced dominant lethal mutations in postspermatogonial stages was dose-dependent. The yield of dominant lethal mutations in spermatogonia was independent of the dose. Pretreatment with chloramphenicol enhanced the frequency of radioinduced dominant lethal mutations only in spermatozoa. Pretreatment with S,2-aminoethylisothiuronium · Br · HBr (AET) reduced the frequency of radioinduced dominant lethal mutations in early spermatids. Chemical mutagens can be characterized by their stage-specific induction of mutations. The straight chain alkyl methanesulfonates, ethyl methanesulfonate (EMS), methyl methanesulfonate (MMS), and n-propyl methanesulfonate (PMS) induced a high frequency of dominant lethal mutations in spermatozoa and late spermatids. The induced dominant lethal mutation rate decreased to the control level of embryonic lethality in early spermatids. No mutations were induced in spermatocytes. The absence of induced mutations in spermatozoa and late spermatids was typical for the spermatogenic response after treatment with mitomycin C. Mutations were induced in early spermatids. Spermatocytes were the most sensitive germ-cell stage for the induction of dominant lethal mutations with mitomycin C. Possible explanations for the differential spermatogenic response to radiation- and chemically-induced dominant lethal mutations are discussed. (auth)

16228 PERSISTENCE OF RADIATION DAMAGE: HEMOPOIETIC EFFECTS IN IRRADIATED MICE TREATED WITH ACTINOMYCIN D. Smith, Willie W.; Wilson, Shirley M. (National Cancer Inst., Bethesda, Md.). pp 49-55 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

For a given lethality, a substantial number of irradiated mice given actinomycin D die in 5.5 to 7.5 days. Some of these deaths were prevented by an injection of bone marrow, thus implicating the hemopoietic system as a determining factor in survival. Although granulocyte counts were not greatly affected by AD alone, in mice given graded doses of AD and 400 rads an hour later, 7-day counts fell from 3300 with 200 μg./Kg. to 250 with 500 μg./Kg. Although a separation of 5 to 6 hours between two sublethal doses of radiation led to higher leukocyte and splenic colony counts and survival than a separation of only a few minutes, with actinomycin D as the second treatment no evidence of recovery from the radiation damage was seen. In fact, these measurements of hemopoietic activity, including femoral CFU, showed evidence of greater injury when AD was given 5 to 6 hours after irradiation than when only a few minutes separated the two treatments. (auth)

16229 BEHAVIOR OF THE ELECTROPHORETIC SERUM PROTEIN PATTERN IN ROENTGEN IRRADIATED RABBITS. IV. PROTECTION FROM RADIATION DAMAGE BY INTRAVENOUS LYSOZYME THERAPY ASSOCIATED WITH IONIZING TREATMENT. **de Serio, N.; Grimaldi, G. (Univ., Bari, Italy). Quad. Radiol.; 33: 125-37(Mar-Apr 1968). (In Italian).**

Rabbits were exposed to daily whole-body x irradiation of 250 R. One group received intravenous lysozyme therapy before the irradiation; but a second group received no treatment. The electrophoretic serum protein pattern was followed in the untreated rabbits until their death (all the rabbits were dead by the twelfth day) and in the lysozyme-treated rabbits for 23 days, at which time all the rabbits were still surviving. The electrophoretic serum protein pattern, determined daily, is tabulated for both groups of rabbits. (J.S.R.)

16230 DIFFERENCE BETWEEN SPLEEN-DERIVED AND BONE MARROW-DERIVED COLONY-FORMING UNITS IN ABILITY TO PROTECT LETHALLY IRRADIATED MICE.

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Kretchmar, A. L.; Conover, W. R. (Univ. of Tennessee Memorial Research Center and Hospital, Knoxville). Contract AT(40-1)-3635. Blood; 36: 772-6(Dec 1970).

Suspensions of cells in the bone marrow and in the spleen of normal mice were prepared. Two groups of lethally irradiated mice were given cells from bone marrow and two groups of lethally irradiated mice were given cells from the spleen of the same donor mouse. One of the groups injected with bone marrow and one injected with spleen cells were killed at 9 days for determination of CFU. The remaining animals were followed for 100 days to determine the mortality statistics. The mortality among mice not given cells was 100 per cent; among mice injected with cells, the mortality was reduced. The data permit a comparison of the reduction in mortality (protection) following injection of bone marrow CFU with protection following injection of spleen CFU. Protection with CFU of bone marrow was different from protection with CFU of spleen. It seems possible that both hemopoietic pluripotent stem cells and early differentiated progenitors can form spleen colonies and that the ratio of these CFU may be different for bone marrow and spleen. (auth)

16231 EFFECTS OF MUMIE PREPARATION ON THE NUCLEIC ACID CONTENT IN THE HEMATOGENIC ORGANS DURING ACUTE RADIATION SICKNESS INDUCED BY LOW-ENERGY RADIATION. Tukhtaev, T. M.; Pauk, S. I. (Tadzhik State Medical Inst., Stalinabad, USSR). Dokl. Akad. Nauk Tadzh. SSR; 13: 62-5(1970). (In Russian).

Effects of ionizing radiation and therapeutic doses of Mumie on the content of DNA and RNA in the marrow and spleen were investigated. Studies were made using 80 rats weighing 160 to 180 g treated with 500 mg/kg Mumie preparation followed by a total-body x-irradiation with a dose of 450 R. The results showed that the small dose irradiation induced a sharp drop of nucleic acids in hemotogenic organs, especially DNA. The changes in RNA in the marrow was comparably less pronounced than in the spleen. However, treatments with the Mumie preparation had a significant effect on nucleic acid metabolism. The restoration of nucleic acids, especially of RNA, was much more rapid and intense in the Mumie treated animals than in the control animals. (R.V.J.)

16232 RADIOPROTECTION BY BEE VENOM. Kanno, Iwao; Ito, Yasuhiko; Okuyama, Shinichi (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi; 29: 1494-1500(Mar 1970). (In Japanese).

Mice of dd strain each weighing about 30 g were subcutaneously injected with bee venom in doses of 2.8 or 5.6 μg/body weight and then subjected to whole-body irradiation of 937 R from a ^{60}Co source. Protective effects of bee venom against irradiation were estimated. The irradiated but untreated mice (control) showed a 100% mortality rate 15 days after irradiation. The mortality rate in bee venom-treated irradiated mice was much less than in the control, and the survival rates by the 60th day were 10% in 2.8 μg group and 18% in 5.6 μg group, respectively. Pathological changes due to irradiation were slight in the spleen and bone marrow from the bee venom treated mice. No direct toxic changes due to the bee venom were found in these organs, however, it was believed to be toxic to the kidneys because degeneration of the renal epithelium and hemoglobin casts due to hemolysis were observed. (auth) (Japan)

16233 CHEMICAL RADIOPROTECTION BY ORGANIC SELENIUM COMPOUNDS IN VIVO. Breccia, Alberto; Badiello, Roberto; Trenta, Alessandro; Mattii, Mario (Univ., Bologna). Radiat. Res.; 38: 483-92(Jun 1969).

The radioprotection afforded by selenocystine, selenomethionine, colloidal selenium, selenoxanthene, selenoxanthone, and selenochromone in living rats was evaluated on the basis of ability to alleviate mortality and leukopenia in rats exposed to irradiations of 600, 750, and 900 R of γ radiation. The results show that these compounds have an action similar to, and sometimes even superior to, that of cysteine. A preliminary study was made of the mechanism of action of the selenium derivatives by measurement of the retention of selenium in the blood, and its distribution at the subcellular level in the liver. (auth)

Radiodiagnosis

Refer also to abstracts 15835, 16006, 16150, 16201, and 16368.

16234 (ACRH-34) SEMIANNUAL REPORT TO THE ATOMIC ENERGY COMMISSION. Gottschalk, Alexander (ed.) (Argonne Cancer Research Hospital, Chicago, Ill.). Sep 1970. Contract AT(11-1)-69. 162p. Dep. NTIS.

Fourteen published articles report results of radiological studies. Those within the scope of NSA have been previously abstracted. A list is included of 64 additional articles submitted for publication during the period covered. (C.H.)

16235 (UCLA-12-803) RAPID ASSESSMENT OF CEREBRAL HEMODYNAMICS. Kennady, John C. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology) [1970]. Contract AT-04-1-GEN-12. 55p. Dep. NTIS.

Results obtained using a γ camera with image intensifier and video data display following the internal carotid injection of ^{99m}Tc-labeled serum albumin microaggregates in 175 patients are reported. Major technical features of the videocamera system, preparation of the test agents, and quantification analysis of the data are described. The clinical results from patients with various types of intracranial pathology (i.e., acute and chronic vascular disease, vascular and avascular tumors, cystic tumors, arteriovenous malformations, idiopathic seizures, and brain trauma) are illustrated as composite 0.5 to 1.0 second sequential Polaroid pictures of the lateral hemisphere. The videocamera study is analyzed using three parameters (i.e., percent mean maximum test agent concentration, arterial-capillary time and inverse $T\frac{1}{2}$) for each 1.5 cm^2 region (grid technique) within the hemisphere following injection of the test agent, and quantitative information about regional cerebral blood flow is obtained. A patient exemplifying each type of intracranial lesion mentioned is described, and results obtained from the diagnostic procedures are analyzed. A brief discussion of cerebral morphometry, the principle of temporary arteriolar blockage, and assessment of the cerebral microvasculature and microcirculation are also given in this review. (auth)

16236 EFFECT OF MERALLURIDE BLOCKING ON LOCALIZATION OF RADIOCHLORMERODRIN IN A MOUSE BRAIN TUMOR (SARCOMA). Konikowski, T.; Haynie, Thomas P. (Univ. of Texas, Houston). Int. J. Appl. Radiat. Isotop.; 21: 711-18(Dec 1970).

As meralluride blocking is commonly used in brain tumor scanning with ^{197}Hg labelled chlormerodrin, and as the effect of this pretreatment on the localization of radiochlormerodrin in brain tumors is not known, the pharmacodynamics of radiochlormerodrin in a mouse brain tumor with and without prior administration of meralluride was studied. Tumor-bearing mice were injected with a constant dose of radioactive chlormerodrin and were pretreated with two dose levels (0.557 μg/g and 5.011 μg/g) of stable meralluride. At varying time intervals after injection of radioactivity, tissue samples were counted, and the degree of localization evaluated. The results reveal differences in mice receiving blocking doses of meralluride where a lesser tissue concentration of radiomercury was found than in mice not receiving blocking doses of meralluride. In addition, different intervals of maximum tumor to brain ratios were observed. Mice receiving blocking meralluride had maximum tumor to brain ratio 1-2 hr after injection, while mice not given stable mercury reached maximum tumor to brain ratios 3-5 hr after injection. The data are thought to have some bearing on selection of optimum scanning time in the clinical brain scanning situation. (auth) (UK)

16237 APPLICATION OF SCINTIGRAPHY TO THE DIAGNOSIS AND POST-OPERATIVE SUPERVISION OF HYDROCEPHALUS CASES. Akerman, M. (Institut National de la Sante et de la Recherche Medicale, Suresnes, France); Said, G.; De Tovar, G. J. Biol. Med. Nucl.; 5: No. 21, 7-11(1970). (In French).

Isotopic cisternography and ventriculography carried out with ^{131}I-serum albumin provide morphological information on the liquid cavities and dynamic information on the circulation and turnover of the cephalo-rachidian liquid. In the hydrocephalus field these functional trials can be used to decide on the means of derivation of the cephalo-rachidian liquid, to check the success of the surgical operation and detect a complementary obstructive complication. (France)

16238 DIAGNOSIS AND RADIATION TREATMENT OF THROMBOPHLEBITIS OF THE SHIN. Podlyashuk, E. L.; Krivenko, E. V.; Frenkel, V. E.; (and others) (Moscow Research Inst. of X-Ray-Radiology). Med. Radiol.; 15: No. 10, 24-32(Oct 1970). (In Russian).

Techniques of precise diagnosis of subacute and chronic thrombophlebitis of superficial and deep veins of the shin on the basis of clinical, laboratory, roentgenological (phlebographic) data and radioisotope investigation were described, as well as the technique of roentgenotherapy of thrombophlebitis of the shin in 44 patients. In contrast to the standard technique the authors employed a more penetrating radiation, reduced the total absorbed doses and shortened the intervals between irradiations. Positive results after radiation therapy were observed in 32 out of 36 patients followed up to two years after

treatment, this being confirmed by data of phlebography and radioisotope investigation. (auth)

16239 ELABORATION OF FUNCTIONAL CLINICAL RADIOISOTOPE INVESTIGATIONS. Tsfasman, A. Z. (All-Union Research Inst. of Railroad Sanitation, Moscow). Med. Radiol.; 15: No. 10, 32-6(Oct 1970). (In Russian).

Clinical investigations involving the use of functional radioisotope methods are elaborated. The clinical problems refer to the clinical assessment and the choice of adequate radioisotope tests. (auth)

16240 IMPORTANCE OF KINETIC LABELLED COMPOUNDS FOR THE FUNCTIONAL ASSESSMENT OF THE LIVER. Modestov, V. K.; Mirkhodzhaev, A. Kh. Med. Radiol.; 15: No. 10, 37-40(Oct 1970). (In Russian).

It is shown that mathematical kinetic models of radioisotope labeled compounds of the type of Rose Bengal and colloidal particles in the organism may be employed for separate quantitative evaluation of the activity of polygonal hepatic cells and hepatic circulation in clinical investigations. (auth)

16241 ^{131}I BILIGNOST (ROSE BENGAL) INVESTIGATION OF THE CONCENTRATION FUNCTION OF THE GALLBLADDER. Adeishvili, V. I. Med. Radiol.; 15: No. 10, 48-54(Oct 1970). (In Russian).

Five patients without diseases of the liver and gallbladder were examined as well as 62 patients with different diseases of the hepatobiliary system. ^{131}I-bilignost was introduced intravenously in a dose of 0.2 μc/kg of body weight. Registration of the rate of counting was continued for 30–40 minutes. Later the measurements were done in 1, 2, and 3 hours. In 2 hours the patient was given two egg yolks after which the determinations were continued. The results of investigations show that ^{131}I-bilignost is convenient for studies of the concentration capacity of the gallbladder. An essential index of the concentration function of the gallbladder was the degree of radioisotope accumulation in the gallbladder at periods 45 to 120 minutes after introduction of the preparation. In diseases of the liver and gallbladder, as a rule, one determines a reduced accumulation of the labeled compound in the gallbladder. Radiometry enables to define the cause of this reduction: decreased concentration capacity or reduction of the volume of the gallbladder. (auth)

16242 THEORETICAL IMAGE-FORMING QUALITY OF FAST-NEUTRON RADIOGRAPHY. Wilkie, William Howard. Atlanta; Georgia Inst. of Tech. (1970). 166p. University Microfilms Order No. 70-24,391.

Thesis.

Fast-neutron radiography is examined theoretically for biomedical applications. Monte Carlo calculational techniques are used to predict the behavior of fast neutrons. The interaction of neutrons with biological tissue and with system components is studied. The validity of the use of modulation transfer functions for examining image-forming quality is established and the mathematical procedures used in the generation of these functions are explained. Dosimetry calculations are made for both broad-beam and narrow-beam geometries. Isodose contours are presented for a right elliptical phantom of standard man composition tissue and for a phantom based on a realistic model of a human chest containing muscle, heart, lung, and bone tissues. The significance of these contours is evaluated in relation to neutron radiography, and the implications for the application of this type of calculation to neutron therapy are described. (TSS) (Diss. Abstr. Int., B)

16243 DIAGNOSIS OF UPPER GASTROINTESTINAL TRACT HEMORRHAGE. Baird, Robert A. J. Amer. Med. Ass.; 214: 598-9(19 Oct 1970).

The limitations of roentgenographic examinations in the diagnosis of upper gastrointestinal tract hemorrhage are cited. These include the failure to visualize potentially bleeding lesions such as erosive gastritis and esophagitis, and the inability to demonstrate whether or not a roentgenographically visible lesion is the site of active bleeding. Endoscopy is recommended as the preferred diagnostic tool. It permits the visualization of all types of lesions above the pylorus, and discrimination between those that are or are not bleeding. The limitation of endoscopy lies in the inability to pass the commonly used endoscopes past the pylorus, below which 30% of the upper gastrointestinal tract hemorrhages occur. By combining endoscopy and roentgenography, the diagnostic failure rate can be reduced from 33 to 36% to 7 to 11%. (E.R.B.)

16244 ^{99m}Tc PERTECHNETATE DISAPPEARANCE STUDIES IN NORMAL AND PSORIATIC SKIN. DiLorenzo, Pasquale A.; Brown, Donald W.; Walker, Strother H.; Dern, Philip L.; Goltz, Robert W. (Univ. of Colorado, Denver). J. Invest. Dermatol.; 56: 39-43(Jan 1971).

A method is presented which proved reliable and reproducible (in two groups of 6 subjects) in monitoring cutaneous vascular function or tracer diffusion from an injection site. The method is based on intradermal injection of ^{99m}Tc pertechnetate and recording disappearance of the isotope continuously with a standard renogram recording system. Standardized computer routines evaluate each record, summarizing the information by determining a half-time for the subject and site. The standard deviation of experimental error is approximately one minute. Within that limit right and left half-times at symmetric uninvolved locations are indistinguishable. Further, the average disappearance half-time from lesions in a group of psoriatics was less, by about 3.5 minutes, than the average disappearance half-time from uninvolved symmetric sites in the same patients. It is concluded that the data presented on normal and pathological disappearance rates contribute to understanding skin pathology and the method will provide an objective basis for evaluation and comparison of drug effects in groups of patients. (auth)

16245 CONTRIBUTIONS TO SCINTIGRAPHY OF THE LIVER, PANCREAS, AND SPLEEN. Barbieri, L. L. (Univ., Bologna). Minerva Med. Giuliana; 8: 389-404(Sep-Oct 1968). (In Italian).

Hepatic scintigraphy has the following objectives: evaluation of liver volume and form; determination of liver dislocation; search for congenital anomalies; inspection of adjoining abdominal organs; search for local pathological conditions such as tumors, cysts, abscesses, necroses, and vascular malformations; differential diagnosis in case of painful inflammation of the right upper abdomen; search for metastases in the liver; preoperative localization of liver abscesses; sequential control of liver tumors or abscesses under treatment; investigation of abdominal injuries in which liver damage is suspected; evaluation of liver damage in chronic cirrhosis; search for clinical information in nonoperable diseases such as coagulative or circulatory disturbances; spleen thromboses recognizable through liver alteration; search for spleno-portal thromboses; and sequential observation of liver regeneration after partial hepatectomy. In case of acute virus hepatitis no pathological changes can be observed by scintigraphy, except perhaps a slight enlargement of the liver. In liver cirrhosis the spleen exhibits an increased reticoendothelial activity and, therefore, a hepatic scintigram made with ^{198}Au not only shows increased spleen activity but also reduced liver size. In addition a relation between splenic-portal hypertension and scintigraphic appearance of the spleen, such as observed in cirrhosis could be established. Scintigraphic examination is very useful in liver tumors. While laparotopsy may show the location of the tumor, particularly if the malignancy is on the surface and biopsy can establish the nature of the disease, this is not possible, when widespread infiltration of the organ has already taken place. In this case only scintigraphic methods will reveal the true extent of the malignancy. But even so scintigraphic visualization is extremely difficult since the observed cold spots need not necessarily be caused by neoplastic processes, but may have various other causes. In general a primary cancer gives a characteristic picture of voids with very irregular boundaries and occasional active areas of regeneration. The difficulty of discerning heteroplastic lesions applies particularly to cysts, though the classical picture of a cyst is a cold area rounded with sharp boundaries and a hypertrophy of the residual paranchymatic tissue. There exist acquired and congenital cysts. The latter are very rarely observed because persons who have them do not know about it and thus seldom come under clinical observation. The pancreas is of special radiological interest inasmuch as its scintigraphic image can be obtained only by indirect visualization. And even this method became possible only after the synthesis of a specific tagged compound by which this organ can be fixed, namely methionine-^{75}Se. The most important method to overcome the liver shadow and the avidity with which the liver captures this tracer for the synthesis of plasma proteins consists in subtracting the scintigraphic image of the liver, made with ^{198}Au by electronic means from the combined image of liver and pancreas made with methionine-^{75}Se. In this way it could be shown for the first time that the scintigraphic image of the pancreas does not correspond to anatomical tests. Cysts or tumors may induce partial or total suppression of the pancreas function up to complete extinction of the organ's image. In acute pancreatitis the scintigraph shows diffuse, yet sharply contrasting areas of underfixation. Like the pancreas it escapes direct radiological examination. However, there exist pathological conditions in which indirect scintigraphy may reveal parenchymatic lesions. In such cases the intravenous injection of mercuryhydroxypropion-^{197}Hg which associates itself with erythrocytes may offer a method for making the spleen visible. The normal spleen gives an image corresponding to its anatomy. In patients having suffered from malaria one often finds

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an enlargement of the spleen. As far as other pathological conditions are concerned that can be detected by scintigraphy are cysts, abscesses, necroses, hemorrhages, and tumors. In various types of leukemia one observed greatly enlarged spleens. Spleen scintigraphy may also be of assistance in the diagnosis of some types of pancreas diseases as well as in the diagnostic confirmation of Hodgkin's disease. (auth)

16246 DIAGNOSTIC VALUE OF SCINTIGRAPHY IN SPLEEN PATHOLOGY. Falcetti, E.; Spina, C.; Trinci, M. (Univ., Rome). Minerva Med. Giuliana; 8: 441-6(Sep-Oct 1968). (In Italian).

As in other organs one uses for the scintigraphic examination of the spleen a specific function of this organ; that is, the capture of damaged or denaturated erythrocytes. An excellent method for making the spleen scintigraphically visible is the tagging of red blood cells with BMHP-^{197}Hg (bromomercury-hydroxypropionate-^{197}Hg) with which one can achieve in short time faithful scintigrams of the spleen. From these scintigrams one can derive data concerning dimension and form of the spleen and the function of its parenchyma. One of the most important pathological changes is splenomegaly, a characteristic symptom of serious blood diseases. Although the spleen can enlarge without change of form, the latter is also possible and indicative of other diseases. Splenomegaly is also observed in Banti's disease usually related to liver cirrhosis. Structural observation of the spleen allows the detection of neoplastic formations that have surpassed the threshold of scintigraphic resolution. In this group fall also conditions that cause destruction of the erythrocyte capturing parenchyma. Destruction of the splenic tissues can also be brought about by echinococcus cysts. Another function of splenic scintigraphy is the detection and localization of infection in the inflammation of the upper left part of the abdomen. An interesting application of splenic scintigraphy is the detection of spleen displacement and of surplus spleen. It is interesting that the tagging compound accumulates after 24 hours in the kidneys so that with one application two different organs can be scintigraphically examined. In the study of ectopic and supernumerary spleen one uses preferably ^{51}Cr for tagging of erythrocytes. The choice of a suitable radioisotope depends primarily on the knowledge of the radiation load to which the patient can be exposed. While the administration of 150 μCi ^{51}Cr produces an absorption of 10 rad by the spleen, the injection of 100 μCi ^{197}Hg causes the absorption of negligible doses of radiation by the spleen, but 7 rad by the kidneys. (F.J.W.)

16247 THYROID SCANNING WITH ^{99m}Tc IN CHILDREN AND ADOLESCENTS. Gorowski, Tadeusz; Chomicki, Oskar; Lenartowska, Irena (Inst. of Mother and Child Care, Warsaw). Nucl.-Med.; 9: 218-25(30 Sep 1970).

Thyroid scanning with ^{99m}Tc was performed on 100 patients between two and 17 years of age with various thyroid disorders. A dose of up to 0.5 mCi was administered orally and the scan was made 90 min later. Good scans were obtained which made it possible to determine the degree of isotope uptake by the thyroid parenchyma and the nodules, the presence of ectopic tissue and changes taking place in the thyroid in thyroiditis, as well as after TSH administration and thyroidectomy. The uptake of ^{99m}Tc by nodules was also estimated. (auth)

16248 ACCURACY OF ROENTGENOGRAPHIC TECHNIQUES IN THE DIAGNOSIS OF RENAL MASS LESIONS. Lang, Erich K. (Louisiana State Univ., Shreveport). Radiology; 98: 119-28(Jan 1971).

The accuracy of various diagnostic roentgenographic procedures in a series of 361 histopathologically proved renal mass lesions was evaluated. The nephrotomogram and renal radionuclide scan were relegated to the position of a survey examination because of the high number of indeterminate studies. The selective renal arteriogram established the diagnosis in vascular renal mass lesions with a high degree of confidence. The combination of intravenous infusion urography, selective renal arteriography, cyst puncture, aspiration, double-contrast cyst study, and chemical and histopathological examination of the aspirant proved to be best for establishing a definitive diagnosis in avascular lesions. (auth)

16249 COMPARATIVE RADIOCARDIOGRAPHIC STUDIES OF CARDIAC AND CIRCULATORY PARAMETERS UNDER CONDITIONS OF BASAL METABOLISM AND HYPERTHERMIA. Pabst, H. W.; Klein, U. (Univ., Munich). Nucl.-Med.; 32: Suppl. 7, 45-51(1968). (In German).

From 5th Conference of the Society of Nuclear Medicine, Vienna, Austria. See CONF-670996.

Heart scintigrams were obtained on persons at room temperature and after a high-temperature bath of 30 min duration. At the end of the bath, blood temperature increased by approximately 1.5°C. During hyperthermia, the cardiac minute volume increased by 60% and the stroke volume by 30%. (H.B.G.)

16250 LINGUAL THYROID: REPORT OF CASE. McDaniel, Raymond K.; Luna, Mario A.; Stimson, Paul G. (Univ. of Texas, Houston). J. Amer. Dent. Ass.; 81: 1156-8(Nov 1970).

An instance of total ectopia of the thyroid gland in the base of the tongue, originally diagnosed as a tumor, is reported and discussed. It is important for dentists to be cognizant of the clinical appearance and symptoms, the anatomic location, and procedures for accurate diagnosis and proper treatment of this developmental lesion. (auth)

16251 DIFFERENTIAL DIAGNOSIS OF GASTRIC DISEASES WITH THE HELP OF RADIOACTIVE PHOSPHORUS ^{32}P. Vannikov, L. L.; Zelenskii, M. I. (State Medical Inst., Novosibirsk, USSR). Vop. Onkol.; 16: No. 6, 14-18(1970). (In Russian).

Radiometric data on ^{32}P inclusion were studied on 95 specimens of the resected stomach, a concentration being 0.5 μc/Kg weight. The investigation ranged from 24 to 48 hours after intravenous injection of sodium diphosphate. On relative values of ^{32}P inclusion (^{32}P accumulation in mucous membrane of the greater curvature of the stomach was taken as 100%) two types of distribution in the antral portion and gastric body were established as well as reliable differences in ^{32}P accumulation in tissues of cancer, polyp, chronic scarring ulcer and ulcer with inflammation. Reduction in the rate of ^{32}P inclusion in dynamics is considered to be a differential sign. (auth)

16252 THYROID DIMENSIONS AS MEASURED ON THE SCINTIGRAM. Horn, Y.; Robinson, E.; Hochman, A. (Hadassah Hospital, Jerusalem). Nucl.-Med.; 9: 226-30(30 Sep 1970).

Thyroid scans using ^{131}I were performed on 61 patients. Forty-one were females and 20 males. Seven patients were hyperthyroid, 43 euthyroid, and 11 hypothyroid. It was found that in most patients the right lobe was larger and wider than the left lobe. Males usually had larger glands than females. The upper pole of the right lobe extended higher in the neck than the left lobe. The value of these findings in relation to treatment of thyrotoxicosis is discussed. (auth)

16253 WHOLE-BODY AND RENAL CLEARANCE OF ^{203}Hg-CHLORMERODRIN. THE EFFECT OF CHELATING AGENTS ON CLEARANCE. Krishnamurthy, G. T.; Lederer, Marianne; Tubis, Manuel; Blahd, William H. (Wadsworth Hospital, Los Angeles, Calif. Univ. of California, Los Angeles. Univ. of Southern California, Los Angeles). Nucl.-Med.; 9: 248-58(30 Sep 1970).

Using a whole-body counter, normal whole-body and renal clearances of ^{203}Hg-chlormerodrin and the action of L-cysteine and D-penicillamine as chelating agents were studied in 19 subjects. L-cysteine and D-penicillamine given in varying doses at different time intervals did not change the whole-body or renal retention of mercury. This indicates that these chelating agents are not effective when mercury is present in the body in minute quantities. The search for better and more convenient renal scanning agents should continue, as should also the search for a better chelating agent to enhance clearance of ^{203}Hg from the body. (auth)

16254 VISUALIZATION OF MEDIASTINAL LYMPH NODES AFTER INTRAPERITONEAL ADMINISTRATION OF ^{99m}Tc-SULFUR COLLOID. Atkins, Harold L.; Hauser, Wolfgang; Richards, Powell (Brookhaven National Lab., Upton, N. Y.). Nucl.-Med.; 9: 275-8(30 Sep 1970).

Mediastinal lymph nodes have been demonstrated in a woman following intraperitoneal administration of ^{99m}Tc-sulfur colloid. Rapid uptake of the material in the lymphatics on the undersurface of the diaphragm resulted in substantial concentration of radioactivity in the lymph nodes in approximately 2½ hours. (auth)

16255 EVALUATION OF ROENTGEN EXPOSURE IN MAMMOGRAPHY. PART II. FOUR VIEWS. Gilbertson, James D.; Randall, Mitchell G.; Fingerhut, Aaron G. (Los Angeles County Harbor General Hospital, Torrance, Calif.). Radiology; 97: 641-7(Dec 1970).

Radiation exposure was measured in 100 female patients undergoing mammography by the Egan technique. Both axillary views were excluded to simulate expected exposures in a large population survey. Additionally, 40 phantom studies were performed on a modified Alderson-RANDO phantom. Every attempt was made to reproduce the clinical situation. Patient dose ranged from background on the dorsum of the left foot to a maximum of 11 R on the surface of the inner breast. This compares to a maximum of 18 R

reported earlier when the axillary views were included. With axillary views omitted, bone marrow measurements showed a 300% reduction in exposure. (auth)

16256 DEMONSTRATION OF LIVER METASTASES BY LIVER-FUNCTION TESTS AND THEIR VISUALIZATION WITH RADIOACTIVE ISOTOPES. Dembski, J. C.; Stroetges, M. W. (Ruhr-Univ., Essen). Deut. Med. Wochenschr.; 95: 313-16 (13 Feb 1970). (In German).

Radioisotope scanning is of only limited value in the diagnosis of liver metastases because such metastases must be at least 1.5 to 2.5 cm. in diameter to be detectable and cannot be distinguished from parenchymal lesions from other causes. Widely spread small nodular metastases cannot be distinguished from diffuse liver cirrhosis by scintigraphy, but there is a statistically high significant difference bdtween these two conditions with regard to their ^{198}Au clearance, which is diminished in cirrhosis. A more important means of demonstrating liver metastases is the increase in liver equilibrium, i.e., the time until there is activity equilibrium over the liver after rectal administration of ^{125}I. The diagnosis of liver metastases was correctly made in 49 of 55 patients with liver metastases by performing scintigraphy, ^{198}Au clearance, and measuring equilibrium time. A false-positive diagnosis was made in 21 patients without liver disease and in 10 with cirrhosis of the liver. The listed tests are well tolerated by the patients and their more widespread use is recommended. (auth)

16257 SCINTILLATION CAMERA IN EMBOLIC ACUTE RENAL FAILURE. Hartenbower, David L.; Winston, Martin A.; Weiss, Edward R.; Coburn, Jack W. (Wadsworth Hospital, Los Angeles. Univ. of California, Los Angeles. Univ. of Southern California, Los Angeles). J. Urol.; 104: 799-802(Dec 1970).

Sodium pertechnetate labeled with ^{99m}Tc and the scintillation camera provided a rapid and safe method to evaluate renal vascular supply in a patient with acute renal failure due to embolic arterial obstruction. Interruption of renal blood flow can be documented or excluded, differentiating this disorder from acute tubular necrosis. This procedure can be used safely and frequently in the management of such cases and the progression or resolution of emboli can be documented. (auth)

16258 LYMPHANGIOGRAPHY: DIAGNOSIS OF NODAL METASTASES FROM TESTICULAR MALIGNANCIES. Wallace, Sidney; Jing, Bao-shan. J. Amer. Med. Ass.; 213: 94-6(6 Jul 1970).

In evaluating the patient with testicular malignancy, it is preferable to perform both testicular and pedal lymphangiography. The lymphatic drainage is delineated more completely so that therapy may be tailored to the individual anatomic distribution. If the testicle has been removed, pedal lymphangiography should be complemented by inferior venacavography, bilateral renal venography, and follow-up pyelography. These studies should provide maximum information as to staging and the extent of nodal metastases. (auth)

Radiotherapy

Refer also to abstracts 16035, 16105, 16130, 16144, 16146, 16147, 16149, 16186, 16190, 16197, 16198, 16208, 16362, 16364, 16365, 16369, 16372, 17646, and 17661.

16259 (ORAU-112) HEMATOLOGIC AND THERAPEUTIC EFFECTS OF TOTAL-BODY IRRADIATION (50 R TO 100 R) IN PATIENTS WITH MALIGNANT LYMPHOMA, CHRONIC LYMPHOCYTIC AND GRANULOCYTIC LEUKEMIAS, AND POLYCYTHEMIA VERA. Andrews, G. A.; Comas, F. V.; Edwards, C. L.; Kniseley, R. M.; Lushbaugh, C. C.; Vodopick, Helen (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.). Dec 1970. 56p. Dep. NTIS.

Eighty-nine treatments of total-body γ irradiation were given in single exposures of 50 R and 100 R at 1.5 R/min to patients with lymphoma, chronic leukemia, or polycythemia rubra vera. The clinical and hematologic responses during a 42-day study period were analyzed according to disease and dose; not unexpectedly the therapeutic responses varied. In lymphoproliferative disorders measurable clinical benefit did not depend solely on the radiation dose; the majority showed some shrinkage of enlarged lymph nodes, liver, or spleen, but the larger dose was not proportionally more effective in all cellular systems. Many required additional therapy within three months but this was not surprising in view of our use of only a single exposure. In granulocytic leukemia, improvement occurred in more than half of the patients. For polycythemia, the most clinically beneficial response appeared to be a decline of the dangerously elevated platelet counts to more normal levels that were maintained for many weeks or months. (auth)

16260 (SZS-18/70) RADIATION PROTECTION SITUATION IN CONTACT THERAPY. II. STATE AND DEVELOPMENT TRENDS IN CONTACT THERAPY WITH REGARD TO RADIATION PROTECTION AND EXPENSES. Makedanz, A. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Aug 1970. 38p. (In German). Dep. NTIS (U. S. Sales Only).

The trend of development of contact radio-therapy is reviewed. Radiation protection, as well as therapeutic and economic aspects are discussed. The expenses involved in the use of various radiation sources (^{60}Co, ^{137}Cs, and ^{226}Ra, and an afterloading apparatus) using ^{192}Ir are outlined. Packed applicators are especially considered. Conclusions are drawn from a comparison of the expenses. (auth)

16261 RADIOTHERAPY OF EWING SARCOMAS. Haass, F.; Jungblut, R.; Heinzler, F. (Univ., Duesseldorf). Strahlentherapie; 140: 133-42(Aug 1970). (In German).

The Ewing sarcoma is a malignant primary bone tumescence, occurring rather rarely in children and adolescents. This kind of a tumescence is of special importance for the radiotherapist because of the high radiosensitivity of the primary tumor as well as of its metastases. Etiology and pathogenesis of this affection are, to a great extent, unknown up to the present. At first, there are uncharacteristic symptoms with local pain and high temperatures; these facts often lead to the wrong diagnosis stating an osteomyelitis, and only a biopsy with histological certification and the radiograph can ascertain the clinical picture. A radical operation is indicated only if there is a local limitation of the tumescence with no indication of metastases. The primary tumor and also the metastases are rather radiosensitive. A dose of 4,000 to 6,000 R at the focus of the primary tumescence is advisable. Only 8% of all patients reach the five-year-limit. (auth)

16262 RADIOTHERAPY OF EOSINOPHILE GRANULOMAS. Bopp, J. H.; Guenther, D. (Univ., Duesseldorf). Strahlentherapie; 140: 143-7(Aug 1970). (In German).

After a short introduction into the clinical picture and the possible etiology of the eosinophilic granuloma, with respect to age, sex, and localization, the therapy of this granuloma is demonstrated. The cases treated at the Strahlenklinik (Clinic for Radiology) in Düsseldorf are discussed. Irradiation therapy by fractionated doses at the betatron is the most promising one. During this therapy method, 2000 to 3000 R in total were administered to the focus by means of fast electrons in 10 to 15 single fractions of 150 to 300 R. (auth)

16263 RETROGRESSION OF HUMAN TUMORS AS INFLUENCED BY INDIVIDUAL RADIATION DOSES AND FRACTIONATION RHYTHMS. Eichhorn, H.-J.; Lessel, A.; Jacob, R. (Robert-Roessle-Klinik, Berlin). Strahlentherapie; 140: 148-55(Aug 1970). (In German).

Investigated are the possibilities whether drastic alterations of single doses and of the manner of fractionation under a persistent total dose can lead to a distinct change in irradiation effects on human tumors in vivo. Patients with bronchial and mamma carcinomas are irradiated, in groups, daily with low single doses (about 250 R TD), or every five days with high single doses (about 500 R TD), or twice with extremely high single doses (about 1000 R TD) every tenth day, consecutively, irradiation is carried out every fifth day with about 600 R TD up to a total tumor dose of about 5500 R TD. Following surgery of the irradiated tumors, the preparations are thoroughly inspected as to their histological properties. Quotas of complete histological destruction of the tumors within the different groups are compared; the results of these tests that are approaching the upper and the lowest clinical limits as to the single doses applied, prove that it is not possible to aid the setting up of new hypotheses for the increase of irradiation effects, by applying high single doses instead of low single doses. (auth)

16264 INTRODUCTION TO ELECTRON BEAM THERAPY. Holcomb, Mack H. Radiol. Technol.; 42: 138-43(Nov 1970).

Electron beams were produced almost forty years ago. Today, they are produced with much more sophisticated equipment that is also more expensive and difficult to calibrate. In comparing an electron beam with a photon (x ray) beam, the following similarities are noted: linear travel and relative biological effectiveness (RBE). It is the dissimilarities, however, that make the electron beam unique; for instance, the rapid beam fall-off in tissue, penetration, efficiency, protection, and scattering. Despite the difficulties encountered in its use, electron beam therapy is rapidly emerging as an effective modality. (auth)

16265 COMPARISON OF HEAVY WATER AND BERYLLIUM AS CYCLOTRON TARGETS FOR FAST NEUTRON PRODUCTION

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FOR RADIOTHERAPEUTIC APPLICATIONS. Parnell, C. J.; Page, B. C.; Chaudhri, M. A. (Hammersmith Hospital, London). Brit. J. Radiol.; 44: 63-6(Jan 1971).

Fast neutron central axis depth doses and spectra produced by bombarding beryllium and heavy water targets with 16 and 10 MeV deuterons were measured, and estimates of the dose-rates at 100 cm from the two targets for various deuteron energies in the range 8 to 16 MeV were made. It is shown that a heavy water target may be useful at 10 MeV with the smaller "compact" cyclotrons as a source of neutrons for radiotherapy. (auth) (UK)

16266 HAEMOLYSIS IN PATIENTS WITH CHRONIC LYMPHOCYTIC LEUKAEMIA DURING EXTRACORPOREAL IRRADIATION OF THE BLOOD. Andersen, Vagn; Karle, Hans; Dige-Petersen, Harriet (Rigshospitalet, Copenhagen). Scand. J. Haematol.; 7: 222-32(1970).

Erythrocyte destruction was studied in six patients with chronic lymphocytic leukemia treated with extracorporeal γ irradiation of the blood (ECI). Before treatment all patients were anemic, and ^{51}Cr-labeling showed an apparent half-life of 14 to 19 days indicating a reduced erythrocyte life span, ^{59}Fe data were suggestive of random destruction of erythrocytes in four of the six patients. During the later part of the ECI period considerable reticulocytosis developed, and increased disappearance rate of ^{51}Cr label was evident after a mean cumulative radiation dose between 18,500 and 34,000 Rads had been reached. This indicates the occurrence of hemolysis which was most pronounced in the one patient with a slightly positive Coombs' test. The ^{59}Fe-curves were either unaffected by the irradiation or showed only minor effects; since labeling was performed immediately before treatment, this indicates that young erythrocytes are less radiosensitive. (auth)

16267 TREATMENT OF RHEUMATOID SYNOVITIS BY INTRA-ARTICULAR ADMINISTRATION OF COLLOIDAL ^{198}Au. Riccabona, G.; Juenger, H.; Juenger, H. (Univ., Innsbruck). Nucl.-Med.; 9: 279-84(30 Sep 1970). (In German).

Twenty-four knee joints in 17 patients with rheumatoid synovitis were treated with colloidal ^{198}Au. The use of radioactive colloids greatly improved the results obtained in this condition. The radiation doses to the abdominal lymph system and to the liver were considered acceptable. (auth)

16268 USE OF LOCAL ANESTHESIA FOR RADIUM IMPLANTATION. Olson, John R. Jr.; Hornback, Ned B. (Indiana Univ., Indianapolis). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 839-41(Aug 1970).

Adaptation of paracervical and pudendal technique of local anesthesia is described for use in placement of intracavitary radium devices in gynecologic cancer. (auth)

16269 CANCER OF THE TONGUE: A STUDY OF THE REGIONAL LYMPH NODE SPREAD. Saxena, Virendra S. (Princess Margaret Hospital, Toronto). Cancer; 27: 38-43(Jan 1971).

Data are reported on different ways for management of the regional neck lymph node metastasis from cancer of the tongue and their effectiveness in controlling disease in this region locally was evaluated. The incidence of lymph node metastasis, its staging, and its relationship with the primary tumor are also discussed briefly. A determinate group of 440 patients with cancer of the tongue treated from 1945 to 1959 at one institute was studied. A total of 287 patients was found to have regional cervical lymph node metastasis either on first admission or during subsequent follow-up of these patients. The incidence of clinically positive cervical lymph nodes rose from 8.2% in T_1 lesions in the primary site to 29.0% in T_3 and 58.0% in T_4 lesions. Block dissection of the neck was done mostly in patients who developed neck lymph nodes at subsequent follow-up or in patients with N_1 disease. This method of management of lymph nodes resulted in local control rate of 20.5 and 24.0% in N_0 stage and 28.5 and 26.0% in N_1 stage at the end of 5- and 10-year periods, respectively. Radiation only was used mostly in patients who had more advanced disease, i.e., N_2 and N_3 stages, or in earlier stage if the patient could not be operated on due to a variety of reasons. Results of radiation treatment in this group were poor, but a handful of patients survived with no evidence of disease up to five and 10 years. It should be realized, however, that a significant number of these patients receiving irradiation were treated during an era of orthovoltage radiotherapy; most of these patients were poor risks, which might account for poor results of irradiation to regional lymph node metastasis from cancer of the tongue. (auth)

16270 COMBINED CHEMICAL AND RADIOLOGICAL TREATMENT OF PATIENTS WITH CANCER OF THE ESOPHAGUS. Balmukhanov, S. B.; Tsoi, A. I.; Dementeva, N. I.; Valieva, R Abdrakhmanov, Zh. N. (Research Inst. of Oncology and Radiology, Alma-Ata, USSR). Vop. Onkol.; 16: No. 6, 7-14(1970). (In Russian).

Eighty patients with cancer of the esophagus were treated by telegammatherapy, receiving 400 rads over a period of 48 hours in combination with colchamine or 5-fluoruracil. The total dose ranges about 4000 to 6000 rads, colchamine, 48 to 60 mg and 5-fluoruracil 4 to 5 gr. The direct antitumor effect was compared with treatment of the same number of patients subjected only to irradiation, and it was shown that in case of combined therapy the complete recovery occurred in 41.2% of cases, while after irradiation alone it occurred in 16.2% of patients. Patients of the first group were prescribed colchamine or 5-fluorouracil according to the method of daily alternation with irradiation. In the second group 5-fluorouracil was injected 2 hours before and colchamine 16 and 2 hours before irradiation. Best results were obtained in patients who were injected these agents prior to irradiation. (auth)

16271 LARGE DOSE INCREMENT IRRADIATION IN TREATMENT OF CEREBRAL METASTASES. Hindo, Walid A.; DeTrana III, Frank A.; Lee, Myung-sook; Hendrickson, Frank R. (Presbyterian-St. Luke's Hospital, Chicago). Cancer; 26: 138-41(Jul 1970).

Fifty-four patients with cerebral metastases were treated with large dose increment radiation, usually in a single exposure of the whole brain. Thirty-one patients were males, with lung as the most frequent primary; 23 were females, with breast as the most frequent primary. The duration of symptoms before patients received treatment varied from one day to 6 months. Brain scans were reported as abnormal (positive for metastases) in the majority of patients prior to treatment. The method employed in treatment consisted of exposing the whole brain through two parallel opposing fields (10 × 15 cm in size) to 1,000 rads in a single exposure with ^{60}Co. Of 54 patients treated, 40 are dead and 14 are a alive. There was complete follow-up on all patients. Sixty-five percent of the patients showed significant improvement following treatment. Three patients died within 48 hr of treatment. The mean life survival was 5.6 months. Routine use of steroids in association with irradiation was employed originally and later discontinued. The role of steroids and irradiation on brain edema associated with tumors is discussed. (auth)

16272 LYMPHOSARCOMAS IN CHILDREN. Pochedly, Carl (Meadowbrook Hospital, East Meadow, N. Y.). N. Y. State J. Med.; 70: 543-51(15 Feb 1970).

The oncology, clinical picture, histologic diagnosis, therapy, and prognosis of lymphosarcomas in children are discussed. Previous and current clinical findings and results of independent research are reviewed. Important factors in the onset of lymphosarcomas are oncogenic viruses and immunologic abnormalities. Clinically they arise within and outside of lymph nodes wherever lymphoid tissue is present. At the time of diagnosis, the disease may appear as localized, regional, or generalized with constitutional symptoms and signs. Clinical manifestations only suggest the presence of the disease, definite diagnosis can be made only by biopsy. On the other hand, histologic appearance does not predict with any degree of certainty the clinical course, extent of involvement, or the prognosis of the disease. Leukemic transformation may occur subsequently to diagnosis of lymphosarcomas; the leukemia does not appear at the time of initial diagnosis. Having determined the anatomic extent of the lymphosarcoma, the clinical stage of the disease is probably the most important factor in treatment planning and estimating the prognosis. In cases where the disease is still localized, surgery and postoperative radiotherapy are indicated. In systemic cases, a course of chemotherapy with antineoplastic drugs (vincristine, cyclophosphamide) is indicated. Chemotherapy may also be used in localized cases in conjunction with surgery and radiotherapy. Where all therapeutic efforts fail, palliation becomes the objective of the treatment. Prognosis is difficult because of the whimsical nature of the disease, but in many cases there is reason for optimism. (E.R.B.)

16273 RADIOTHERAPEUTIC RESPONSE OF PLASMA CELL TUMORS ASSOCIATED WITH MONOCLONAL GAMMOPATHY. Maryuama, Y.; Thomson, J. Jr. (Univ. of Minnesota, Minneapolis). Cancer; 26: 110-13(Jul 1970).

Radiation therapy response of localized plasma cell tumors was observed with regard to specific protein synthesis, i.e., monoclonal gammopathy. The patients were well controlled by x-ray therapy alone, and the disappearance of abnormal proteins in serum was useful to follow response to therapy by monitoring the monoclonal components as well as the radiographs. The course of the disease was characterized by progression and the appearance of multiple lesions. (auth)

16274 TREATMENT OF TESTICULAR GERM CELL MALIGNANCIES. Maier, John G.; Van Buskirk, Kryder. J. Amer. Med. Ass.; 213: 97-8(6 Jul 1970).

A total of 839 patients were treated at Walter Reed General Hospital for malignant germ cell tumors of the testis from 1940 to 1968. The probability for ten-year survival of all the patients in the series was 60% according to Berkson and Gage. Results in specific histologic types and various degrees of tumor advancement were reviewed with presentation of current methods of treatment. (auth)

16275 MEDICAL RADIATION PHYSICS. Hendee, William R. Chicago; Year Book Medical Publishers, Inc. (1970). 599p. $25.00.

Information is included on the following topics: structure of matter; radioactive decay; interactions of particulate radiation; production of x rays; x-ray circuits; teletherapy units high-energy x-ray generators; interactions of x- and γ rays; radiation intensity and exposure; radiation dose (units, measurements, and calibration); absorbed dose measurements with ionization chambers; radiation quality; interaction of x- and γ rays in the body; radiation fields within a patient in relation to both dosimetric considerations and clinical applications; moving source and implant radiotherapy; detectors for low-activity sources; accumulation and analysis of relevant nuclear data; γ spectrometry and clinical use of radioactive nuclides; measurement of internal radioactivity with external detector; roentgenography; fluoroscopy; cinematography, image modification, tomography, and other topics in physics of radiologic diagnosis; quality of the radiologic image; protection from external sources of radiation; and protection from internal sources of radiation. Some pertinent mathematical tables are appended, and a subject index is included. (E.R.B.)

Blast and Thermal Effects

16276 (FOA-1-1449) SURVEY OF NUCLEAR EXPLOSION EFFECTS ON MAN. KLANGMAN 68. Nelson, A.; Nilsson, A.; Luening, K. G.; Walinder, G.; Schildt, B.; Frankenberg, L. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Oct 1968. 87p. (In Swedish). Dep. NTIS (U. S. Sales Only).

A survey of recent knowledge regarding the biological effects from nuclear explosions is presented as a tool for planning field research efforts. The subject subdivisions are zones of characteristic effects; acute radiation injuries and their effects; radiation damages on the central nervous system; chronic radiation injuries; biological effects from internal contamination; genetic effects; burning effects; blast effects from nuclear explosions; and combined effects. (Sweden)

Radiation Effects on Animals

Refer also to abstracts 15849, 15850, 16044, 16096, 16101, 16217, and 16345.

16277 (AED-C-4-32) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 4: RADIATION EFFECTS ON LIVING TISSUES AND ORGANISMS. Stahlhofen, Willi (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Aug 1970. 151p. Dep. NTIS (U. S. Sales Only).

Approximately 1,000 references are presented to literature on the effects of ionizing radiations on the biochemistry, morphology, and physiology of biological materials. Abstracts of most of the references appeared in NSA Vols. 20 and 21. (C.H.)

16278 (NIRS-9) ANNUAL REPORT, 1969-1970. (National Inst. of Radiological Sciences, Chiba (Japan)). Oct 1970. 87p. Dep. NTIS (U. S. Sales Only).

Separate abstracts were prepared for the four sections presented. Also, the organization, staff, and publications are listed. (W.H.K.)

For abstracts of individual sections see: 15998, 16279, 16306, and 17257.

16279 (NIRS-9, pp 15-53) BIOLOGICAL STUDIES. (National Inst. of Radiological Sciences, Chiba (Japan)).

From Annual Report, 1969-1970.

Brief summaries are presented of results of research studies during 1969. Unpublished data are presented from studies on: the effects of various doses of fast neutrons or γ radiation on the survival of larvae of Artemia (brine shrimp); effects of γ-irradiated extracts from thymocytes on the survival of rat thymocytes in vitro; effects of γ radiation on energy metabolism in yeast; the effects of whole-body x irradiation on the activity of adenosine triphosphatase and glucose-6-phosphatase in rat liver; effects of sulfhydryl content on the x radiosensitivity of HeLa cells; effects of various doses of x radiation on the rate of DNA synthesis in cultured mouse leukemia cells; effects of 5-hydroxytryptophan (5-HTP) on the x radiosensitivity of cultured sarcoma cells; effects of cysteamine on the uptake of ^{3}H-thymidine by intestinal epithelial cells in x-irradiated goldfish (Carassius auratus); effects of uv irradiation on melanopose systems in isolated nerve cells of the goby fish (Chasmichthys gulosus); a comparison of ultrastructural and metabolic factors that may influence the difference in x radiosensitivity observed in cultured mouse melanoma cells and HeLa cells; effects of whole-body x irradiation on metabolic systems in rat liver; effects of hydroxyurea on the x radiosensitivity of mice following abdominal exposure; effects of abdominal x irradiation on the formation of endogenous hematopoietic colonies on the spleen of mice; effects of x irradiation of the head on electrical activity in the brain of mice; mechanisms involved in the induction of mutations of Saccharomyces cerevisiae by uv or x irradiation; and the long-term genetic effects of x irradiation on Drosophila melanogaster populations. (C.H.)

16280 HYPOTHESIS CONCERNING THE RELATIONSHIP BETWEEN NORMAL AND LEUKEMIC HEMOPOIESIS IN ACUTE MYELOID LEUKEMIA. Killmann, Sven-Aage (Univ. Hospital, Copenhagen). pp 267-77 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

A proposal is made that acute myeloid leukemia (AML) is a neoplasia that resides in the common hemopoietic stem cell. In part, the progeny of the diseased stem cell is able to differentiate. To explain some clinical aspects of AML, a clonal succession of normal and leukemic stem cells is suggested. The causes of radioinduced leukemia are discussed in relation to a hypothetical stem pool. The radiation damages the normal stem cell and the abnormal sleeper becomes manifest. (auth) (F.M.M.)

16281 RADIOSENSITIVITY OF CELLS IN DIFFERENT PHASES OF THE MITOTIC CYCLE. Mitrofanov, Yu. A. Usp. Sovrem. Genet.; 2: 125-60(1969). (In Russian).

Radiosensitivity of cells in the G_1, S_1 and G_2 phases of the mitotic cycle was studied using radioautographic methods in order to establish the relative radiosensitivity of cells and various types of chromosome reconstructions. Lethal radiation effects on cells, effects of ionizing radiation on the mitotic cycle, radioinduced inhibition of DNA synthesis, analysis of radiosensitivity of cells based on the chromosomal aberrations and types of aberrations, and analysis of the cell sensitivity at various phases using clone culture methods are briefly reviewed. Extensive references are included. (R.V.J.)

16282 HEMIC CELLS IN VITRO. A Symposium of the Tissue Culture Association, San Juan, Puerto Rico, June 11-13, 1968. Farnes, Patricia (ed.). Baltimore; Williams and Wilkins Company (1969). 190p. (CONF-680635).

Separate abstracts were prepared for three papers presented at the conference. An additional seven papers were presented on various aspects of cellular immunity. (H.L.W.)

For abstracts of individual papers see: 16023, 16056, and 16283.

16283 EFFECT OF A HERPES GROUP VIRUS (EBV) ON GROWTH OF PERIPHERAL LEUKOCYTE CULTURES. Diehl, Volker; Henle, Gertrude; Henle, Werner; Kokn, Gertrude (Univ. of Pennsylvania, Philadelphia). pp 92-9 of Hemic Cells in Vitro. /Farnes, Patricia (ed.). Baltimore; Williams and Wilkins Co. (1969).

From Symposium of the Tissue Culture Association, San Juan, Puerto Rico. See CONF-680635.

Leukocytes from patients in the acute stage of infectious mononucleosis grew readily in suspension culture without resort to any particular manipulations. Establishment of lines from leukocytes of the other types of donors appeared to be aided by initial seeding onto WI-38 cells. Growth was obtained, but not regularly, if the donors of the cells had a past history of IM and/or antibodies to EBV, but apparently rarely if the donors had no history of IM and/or no antibodies to EBV. On co-cultivation of leukocytes from healthy donors with lethally x-irradiated blastoid cells of certain EBV-positive, but not of EBV-negative lines, growing cultures were obtained in an appreciable proportion of trials, especially when leukocytes from infants were employed. Under these conditions, cultures of cells from donors without antibodies to EBV generally started to grow earlier than those from

XUM

donors with antibodies. The sex chromosomes were employed as markers to identify the growing cells as descendants of the leukocytes. Growing cultures obtained by any of these techniques regularly revealed the presence of EBV at some time in a variable fraction of the cells. The virus was derived either from the leukocytes of the donors, who possess antibodies and therefore had been previously infected, or from the x-irradiated blastoid cells, certainly in those co-cultivation experiments in which leukocytes from infants without antibodies to EBV were used. All cultures which were examined cytogenetically revealed the presence of the C-group chromosomal marker which had previously been observed in cultured Burkitt tumor cells. These findings suggest, but do not prove irrefutably, that EBV stimulates growth of peripheral leukocytes in culture and that it is responsible for induction of a persistent specific chromosomal lesion. For final evaluation of these suggestions it will be necessary to expose leukocytes to potent, highly purified suspensions of EBV, a requirement which is presently difficult to meet because of the inadequacy of available methods of purification and the apparent lability of this virus. (auth)

16284 THE SURVIVAL OF ^{51}Cr-LABELED ERYTHROCYTES IN DEPENDENCE TO THE DOSE OF WHOLE-BODY X-IRRADIATION. Prouza, Z.; Pospisil, J.; Dienstbier, Z. (Charles Univ., Prague). Strahlentherapie; 140: 221-30(Aug 1970).

The dependence between the size of absorbed dose after whole-body x-irradiation of organism and the erythrocyte survival half-time was studied. The erythrocytes were labeled with ^{51}Cr. It was found that whole-body irradiation shortens the survival of erythrocytes and this shortening is directly proportional to the size of absorbed dose. The study was performed in rats, guinea-pigs and dogs. Simultaneously the outline of the mechanism of changes causing the shortening of erythrocyte survival half-time after whole-body irradiation of the organism was presented. (auth)

Invertebrates

Refer also to abstracts 16028 and 16098.

16285 (CONF-701202-1) METHODS AND EQUIPMENT FOR IRRADIATING INSECTS. James, Paul E. (Agriculture Research Service, Beltsville, Md.). [1970]. 18p.

From Meeting on American Society of Agricultural Engineers, Chicago, Ill.

Methods for the irradiation of insects are discussed and the design features of several ^{137}Cs or ^{60}Co γ irradiators are evaluated. The geographical location of insect irradiators in the USA is given. Four methods for handling insects during insertion or removal from the irradiators are described and the merits and drawbacks of each are discussed. (C.H.)

16286 SIMILAR EFFECTS OF X-IRRADIATION AND PIPERONYL BUTOXIDE ON TOXICITY OF MALATHION AND MALAOXON TO HOUSE FLIES. Ware, George W.; Whitacre, Gertrude K. (Univ. of Arizona, Tucson). J. Econ. Entomol.; 63: 1621-2(Oct 1970).

Application of piperonyl butoxide to adults and x irradiation of Musca domestica L. pupae with 10,000 R caused similar and additive effects when flies were treated topically with malathion or malaoxon. Malathion toxicity was inhibited by piperonyl butoxide or x irradiation of pupae, while malaoxon was synergized. The implication is that pupal x irradiation and piperonyl butoxide have similar modes of action in combination with malathion or malaoxon. (auth)

16287 EFFECT OF POST-TREATMENT TEMPERATURE UPON WORKER HONEY BEES EXPOSED TO VARYING DOSES OF ^{60}Co GAMMA RADIATION. Oertel, Everett; Lambremont, Edward N. (Louisiana State Univ., Baton Rouge). Ann. Entomol. Soc. Amer.; 64: 268-70(Jan 1971).

The mean survival time of non-irradiated adult worker honey bees, and bees exposed to 3700 or 5000 rad of ^{60}Co gamma radiation is inversely proportional to the post-irradiation temperature. Radiation reduced the lifespan by 50% at the lower temperature (16°C) and up to 75% at higher temperatures (25° and 33°C). (auth)

16288 EFFECT OF GAMMA RADIATION UPON LIFE EXPECTANCY AND REPRODUCTION IN THE HOUSE CRICKET, ACHETA DOMESTICUS (ORTHOPTERA: GRYLLIDAE). Hunter, Preston E.; Krithayakiern, V. (Univ. of Georgia, Athens). Ann. Entomol. Soc. Amer.; 64: 119-23(Jan 1971).

Effects of various doses of gamma radiation upon life expectancy and reproduction of Acheta domesticus (L.) were investigated following gamma irradiation of 2.5 ± 0.5-day-old adults. Radiation levels used were: 0 (controls); 500; 1000; 2000; 4000; 6000; 8000; and 10,000 R. Radiated crickets were mated to nonirradiated crickets. All tests were carried out at 30°C and 70% RH. The results of the studies are summarized as follows: life expectancy of female crickets was increased by 500, 1000, and 2000 R of gamma radiation. Life expectancy of male crickets was not significantly increased at these same radiation levels. Radiation doses from 4000 to 10,000 R significantly reduced life expectancy in both sexes. Fecundity, measured as oviposition, was reduced as the radiation dose was increased from 500 to 4000 R. No eggs were laid at doses above 4000 R. The oviposition period decreased significantly with an increase in radiation dose. Fertility of irradiated females was reduced at both 500 and 1000 R, and no eggs hatched from females exposed to 2000 R. Total F_1 mortality increased with an increase in radiation dose. However, the duration of the nymphal period and nymphal mortality was not affected by radiation. (auth)

16289 MORTALITY AND ABNORMALITIES CAUSED BY GAMMA IRRADIATION OF ALFALFA WEEVIL LARVAE. Burgess, Edward E.; Bennett, Stelmon E. (Univ. of Tennessee, Knoxville). Ann. Entomol. Soc. Amer.; 64: 88-90(Jan 1971).

The effects of gamma radiation on 3rd- and 4th-stage larvae of the alfalfa weevil, Hypera postica (Gyllenhal) (Coleoptera: Curculionidae) were studied. The 3rd-stage larvae were irradiated at 2 to 10 kiloröntgens (kR). Mortality was almost 100% at all radiation levels. The few specimens that pupated died in the pupal stage. Fourth-stage larvae were irradiated at 0.5–10 kR. The 4th-stage larvae were not as adversely affected as the 3rd-stage larvae. However, when the surviving 4th-stage larvae became pupae, mortality increased to 100% (at the 4-kR and higher rates). Specimens that emerged after radiation at lower levels had abnormal antennae, legs, and elytra. (auth)

16290 INFLUENCE OF VERY WEAK ^{60}Co IRRADIATION ON THE DEVELOPMENT OF DROSOPHILA MELANOGASTER. Giess, Marie-Claude; Planel, Hubert; Blanquet, Yolande (Toulouse Univ.). Compt. Rend., Ser. D; 271: 1410-13(19 Oct 1970). (In French).

The behavior of batches either shielded from radiation during development or subjected to very small doses of ionizing radiations was studied. Apart from the radioactivity all physical conditions are identical for the shielded and irradiated batches. The changes observed in the development of radiation-shielded Drosophila melanogaster are found to be connected with the decreased intensity of natural irradiation in the vicinity of these batches. (France)

16291 ABSTRACTS OF PAPERS PRESENTED AT THE TENTH ANNUAL MEETING OF THE AMERICAN SOCIETY FOR CELL BIOLOGY, SAN DIEGO, CALIFORNIA, 19, 20, AND 21 NOVEMBER 1970. J. Cell Biol.; 47: No. 2, 1a-251a(Nov 1970). (CONF-701107-(Absts.)).

Abstracts of 643 papers are presented. Papers within the scope of NSA include radioinduced delay of cell division in Tetrahymena; effects of x radiation on duration of cell cycle in cells of mouse duodenum; and effects of ^{252}Cf and ^{226}Ra mammalian chromosomes. An author index is appended. (H.L.W.)

16292 GENETIC STUDIES IN THE COSMOS. Glembotskii, Ya. L. Kosm. Issled.; 8: 616-27(Jul-Aug 1970). (In Russian).

Effects of cosmic radiation on three types of insects, Drosophila, Habrobracon, and Tribolium, are discussed. Data obtained during 1961 to 1968 in the USSR and the USA on radiation, weightlessness, vibration, and acceleration are included. (R.V.J.)

16293 LABORATORY STUDIES ON RADIATION-INDUCED DOMINANT LETHALITY IN SPERMS IN POPULATION CONTROL OF THE MOSQUITO CULEX PIPIENS FATIGANS WIED. Koshy, T.; Singh, S. P. (Inst. of Nuclear Medicine and Allied Sciences, Delhi). Int. J. Radiat. Biol.; 18: 521-30(1970).

A convenient method for sterilizing the males of the mosquito was described, with reference to the requirements of field application. Cobalt-60 γ radiation doses that result in 96 to 98.8 per cent sterility had no adverse effects on the males. As the ratio of sterile males to normal males was increased there was a corresponding increase in the number of sterile egg-rafts, showing that the mating competitiveness of the irradiated males was equal to the normal males. (auth) (UK)

16294 TOXICITY OF INSECTICIDES TO IRRADIATED AND UNIRRADIATED PINK BOLLWORM MOTHS. Wolfenbarger, Dan A.; Graham, H. M. (Agricultural Research Service, Brownsville, Tex.). J. Econ. Entomol.; 63: 1692-3(Oct 1970).

Experiments were conducted to determine the effects of insecticides on γ-irradiated pink bollworm moths. Differences in susceptibility to insecticides applied to control the pink bollworm or other cotton insects could effect the necessary ratio of sterile to native insects in the field during a sterile-insect release program. The susceptibilities of ^{60}Co γ-irradiated insects to azinophosmethyl, methyl parathion, carbaryl, azodrin, and malathion were tested. The toxic effects of the insecticides were about equal in the control and irradiated groups except for methyl parathion. Its toxicity was greater in the irradiated moths than in the non-irradiated control moths. (E.E.H.)

16295 FERTILITY AND FECUNDITY OF DERMACENTOR VARIABILIS REARED FROM RADIOISOTOPE-TAGGED LARVAE. Sonenshine, Daniel E. (Old Dominion Univ., Norfolk, Va.). Contract AT(40-1)-3514. J. Econ. Entomol.; 63: 1675-6(Oct 1970).

The reproductive capacity of adult ticks subjected to chronic internal β radiation was studied. Larvae of American dog ticks were labeled with ^{14}C, raised to reproductive age, and their reproductive capacity was observed. Results showed that Dermacentor variabilis adults raised from radioisotope-labeled larvae can be expected to reproduce normally. This has important implications regarding the use of such populations in ecological studies. (E.E.H.)

16296 MATING OF NORMAL AND STERILIZED COLONIZED AND NATIVE CORN EARWORMS WITH EMPHASIS ON FAILURE OF PAIRS TO SEPARATE AFTER COPULATION. Snow, J. Wendell; Lewis, W. J.; Sparks, A. N. (U. S. Dept. of Agriculture, Tifton, Ga.). J. Econ. Entomol.; 63: 1873-8(15 Dec 1970).

Normal and ^{60}Co γ radiation sterilized native and laboratory-reared male Heliothis zea were caged with native and laboratory-reared females in all possible combinations. Locking, i.e., failure to separate after copulation, occurred in at least 39% of all matings involving laboratory-reared males and rose to an average of 60% of matings between sterilized laboratory-reared males and native females. The mating and locking characteristics were associated closely with the type of male; egg production was affected significantly by the type of male and female. (auth)

16297 RECOVERY AND ACCUMULATION OF RADIATION EFFECTS AT LOW DOSE-RATE IN SARCOPHAGA PUPAE. Sakka, Masatoshi (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi; 29: 1405-7(Feb 1970). (In Japanese).

Pupae of Sarcophaga peregrina, Robineau-Desvoidy have an identical radiosensitivity for inhibition of imago formation during the first three days of their pupal life when irradiated with a β source at a distance of 15 mm to 20 cm with a relative intensity of 1 to 0.64×10^{-2}, the mean lethal dose being (3.27 to 3.37) × 5350 rep. Irradiation was carried out at a distance of 37 cm with a relative intensity of 1.94×10^{-3}. Different doses were delivered by variation of time of exposure, the shortest being 1 day (24 ± 0.2 hours) and the longest, 3 days. When irradiation began at day 0 of pupal life, mean lethal dose was estimated at 2.5 days which delivered 6.98×5350 rep. Shapes of survival curves did not differ significantly because relative width of one probit to mean was 24 and 31% for strong and weak irradiation, respectively. Therefore larger MLD for weak exposure is explained by a loss of radiation injury during exposure. When the insects were irradiated for 2 days during the first 3 days of pupal life with an interval of 1 day, the lethal effect may be minimal for fractionated irradiation with an interval of 1 day, assuming a postirradiation recovery. Experiments showed, however, no significant difference; 71.7 to 78.7% for irradiation of day 1 and 2, and 76.5 to 78.0% for irradiation of day 0 and 2. It is explained by an accumulation of low dose-rate effects without recovery during the interval. Weak irradiation was of the order of 5 rads/min. (auth) (Japan)

16298 EFFECT OF ^{137}Cs GAMMA RAYS ON REGENERATION IN TUBULARIA. Slaughter, Margaret; Rose, Florence C.; Liuzzi, Anthony (Yale Univ., New Haven. Tulane Univ., New Orleans. Marine Biological Lab., Woods Hole, Mass.). Biol. Bull.; 138: 194-9(Apr 1970).

Short tentacles developed on hydranths regenerated from stems of Tubularia exposed to ^{137}Cs γ irradiation at exposure levels of 10,000 R and 20,000 R. Those hydranths that did regenerate from irradiated stems tended to drop off sooner than hydranths regenerated from un-irradiated stems. Exposures of 150,000 R and 200,000 R completely stop regeneration in Tubularia; 300,000 R is fatal to the organism. The observed delay in time of regeneration increased as the exposure levels increased and thus appeared to be dose dependent. (auth)

Vertebrates

Refer also to abstracts 16012, 16021, 16025–16027, 16029, 16032, 16039, 16041, 16043, 16046, 16051, 16052, 16055, 16058, 16062, 16076, 16090, 16092, 16093, 16097, 16102, 16103, 16196, 16214, 16218, 16219, 16222–16232, 16234, and 16236.

16299 (AD–702723) ALTERATION OF POSTIRRADIATION HYPOTENSION AND INCAPACITATION IN THE MONKEY BY ADMINISTRATION OF VASOPRESSOR DRUGS. Miletich, D. J.; Strike, T. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Jan 1970. 15p. (AFRRI-SR–70-1). CFSTI.

The effects of vasopressor drugs on the early hypotension and incapacitation observed in monkeys following a 4-krad pulsed dose of mixed gamma-neutron radiation were investigated. Seven monkeys received only the 4-krad dose of radiation and served as controls. Norepinephrine or angiotensin was administered to five other monkeys by intravenous infusion from 5 minutes prior to irradiation until death, except that infusion was temporarily interrupted several times after irradiation of the animals. Blood pressure was continuously monitored in all animals. Drug-induced blood pressure elevation prior to irradiation did not prevent the characteristic early postirradiation fall in mean blood pressure, but severity of the resulting hypotension was reduced. Cessation of drug infusion after irradiation resulted in a rapid drop in blood pressure with the animal becoming incapacitated (loss of consciousness) when mean blood pressure fell below a critical level of about 50 mm Hg. After drug infusion was resumed, consciousness returned as the blood pressure rose above the critical level. This sequence was repeated several times before the animal failed to respond to drug administration and died abruptly in a hypotensive state. Five other monkeys were given a single intravenous injection of ephedrine or amphetamine 1 hour before irradiation; these animals received no further treatment. Ephedrine administration appeared to be as effective at maintaining satisfactory postirradiation blood pressure as norepinephrine and angiotensin. (auth)

16300 (AD–709920) CARDIOVASCULAR RESPONSE OF BEAGLES TO A SUPRALETHAL DOSE OF MIXED GAMMA–NEUTRON RADIATION. Turbyfill, C. L.; Thorp, J. W.; Wise, D. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). May 1970. 14p. (AFRRI-SR–70-4). NTIS.

Unshielded, head-shielded or trunk-shielded beagles were irradiated with a 19,000-rad midline tissue dose of pulsed mixed gamma-neutron radiation. The cardiovascular response of the beagle and its alteration by shielding were evaluated. Arterial pressure, blood volume, heart rate, and some plasma chemistry values were determined before and for 1 hour following irradiation. Immediately after irradiation the blood pressure increased in all groups. This prompt hypertension gradually decreased until by 4 minutes postirradiation near normal values were reached; however, the arterial pressure of the head-shielded group declined further and remained lower than those of the unshielded and trunk-shielded animals. In general, this difference was statistically significant beyond 8 minutes postirradiation. No significant difference among the three groups was found in the blood volume, heart rate, hematocrit, or serum chemistry values studied. (auth) (USGRDR)

16301 (AD–709938) MINIATURE PIG PERFORMANCE AFTER FRACTIONATED DOSES OF RADIATION: TIME–DOSE RELATIONSHIPS. Chaput, R. L.; Kovacic, R. T. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Jun 1970. 24p. (AFRRI-SR–70-5). NTIS.

Miniature pigs were trained to traverse, on cue, a two-chambered shuttlebox. Six groups of five to eight pigs received a 4400-rad midline tissue dose of pulsed mixed gamma-neutron radiation followed 1/2, 1, 5, 15, 24, or 51 hours later by a second dose of equivalent magnitude. Two other groups of eight pigs received a lower initial dose (1700 or 3400 rads) followed 1 hour later by a second dose of 4800 to 5000 rads. In addition, unfractionated doses of either 4500 or 8600 rads were given to two groups of six pigs. Regardless of the time interval between the two 4400-rad doses, performance was generally better after the second dose than after the first. Early transient incapacitation, accompanied always by convulsions, and occasionally by coma, consistently occurred after the first dose but was infrequent after the second. When early transient incapacitation did occur after the second dose, it was generally shorter than after the first dose and accompanied by ataxia and disorientation; convulsions and coma were very infrequent. Because of this reduced response to the second 4400-rad dose, performance after an 8800-rad fractionated dose was markedly better than after an 8600-rad unfractionated dose. (auth) (USGRDR)

XUM

16302 (AD-709971) RADIATION EFFECTS ON AUDITORY AND VISUAL DISCRIMINATION TASKS IN MONKEYS. Technical Progress Report. Bogo, V.; Hutton, R. A.; Bruner, A. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Mar 1970. Contract DA-49-146-XZ-359. 27p. (DASA-2460). NTIS.

Following shock-avoidance training on color and auditory discrimination problems, 12 rhesus monkeys were exposed to either 1500 or 6000 rads of pulsed, neutron-gamma radiation. Testing began one hour after irradiation. All monkeys exhibited performance decrement in the form of generalized incapacitation shortly before death, which occurred earlier for the 6000-rad animals. Prior to onset of the moribund state, however, no significant changes in performance were observed, although marked fluctuations in individual performances were evident. Of the response measures used, response latency underwent more change following irradiation than discrimination accuracy. (auth) (USGRDR)

16303 (AD-710005) EFFECT OF MICROWAVE IRRADIATION ON THE TURNOVER RATE OF SEROTONIN AND NOREPINEPHRINE IN RAT BRAIN. Annual Summary Report No. 1, June 1969–May 1970. Snyder, Solomon H. (Johns Hopkins Univ., Baltimore, Md.). 15 May 1970. Contract DADA17-69-C-9144. 18p. NTIS.

This is a report covering the first year of a research program directed at detecting neurochemical alterations in laboratory animals exposed to microwave irradiation at levels of 10 mW/sq cm. At this low level of irradiation, we found that after 7 days exposure for 8 hours per day, there was a marked slowing of serotonin turnover in rat brain. This suggests that microwave irradiation decreased the firing rate of serotonin neurons in the brain. Since these neurons are known to participate in the regulation of sleep and wakefulness as well as body temperature, our findings may account for certain of the behavioral effects purportedly produced by microwave exposure. (auth) (USGRDR)

16304 (CEA-CONF-1591) QUANTITATIVE KINETIC STUDY OF ERYTHROCYTE POPULATIONS BY MEANS OF A MATHEMATICAL METHOD OF CELL VOLUME DISTRIBUTION ANALYSIS. Le Go, A. (Institut National de la Sante et de la Recherche Medicale, Paris (France)); Le Go, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 34p. (In French). (CONF-700820–1). Dep. NTIS (U. S. Sales Only).

From 13th International Congress of Hematology, Munich, Germany.

A study of the erythrocyte spectra was made after 725 rad whole body irradiation of rats, showing the changes arising during periods of erythropoietic depopulation and restoration. In the normal state there seem to be two erythrocyte populations of distinct median volume. The changes in the spectra can be interpreted as variations in the strength of the two normal populations. They may also be the result of the intervention of a third short lived macrocytic population leading to an increase in the mean globular volume. By means of a program of adjustment and decomposition of the spectra into their normal components, it is possible to obtain an estimate of the development of the erythrocyte populations during various pathological states. (France)

16305 (LF-tr-33) COMPARATIVE INVESTIGATION OF CHANGES IN THE LUNGS OF RABBITS AFTER IRRADIATION OF THE THORAX WITH 200 kV-ROENTGEN, COBALT GAMMA AND 17,3 MeV ELECTRONS. Kranz, D.; Kunz, J.; Degner, W. Translated by A. A. Horvath (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.), from Frankfurt. Z. Pathol.; 76: 361-9(1967). 13p. Dep. NTIS.

Groups of 30 rabbits were exposed to a single thoracic dose of 2000 to 12,000 R using conventional x rays, 17.3 MeV electrons, and ^{60}Co γ radiation. After a latent phase of several months, severe pulmonary changes resulted from doses of 2000 to 3000 R. Pathological changes are described according to stages. In the first stage distinct disturbances in permeability were noted. Changes included intraalveolar edema, congestion of capillaries, arterioles, and venules, and enhanced production of mucus by the bronchial glands. In the second stage there were pronounced exudative phenomena and cellular metaplasia. The third stage, or stage of fibrous transformation, was characterized by degenerative changes in the cells and polymorphism of nuclei of the alveolar cells and bronchial epithelium. Considerable increase and hyalinization of collagen fibers in the alveolar septa as well as fragmentation of elastic fibers were observed. (H.L.W.)

16306 (NIRS-9, pp 55-61) MEDICAL STUDIES. (National Inst. of Radiological Sciences, Chiba (Japan)).

From Annual Report, 1969–1970.

Results are reported from studies on the radioresistance of antibody-producing cells. Cell-impermeable millipore diffusion chambers, containing 2.4×10^7 dispersed spleen cells from previously immunized C3H/He mice and 2.4×10^6 sheep red blood cells (RBC), were implanted into the peritoneal cavities of genetically compatible mice which had received 600 R of whole-body irradiation a few hours earlier. Seven days later, when the peak repose was attained, the chamber-bearing mice were exposed to varying doses of γ rays from ^{60}Co (dose rate: 5,700 R/min); then the chambers were removed and reimplanted into the peritoneal cavities of a second set of 600 R-treated recipient mice. The number of spleen cells producing specific antibodies against sheep RBC was assayed by the hemolytic plaque formation in agar gels. The results indicated that three days after irradiation the irradiated chambers contained much fewer nucleated cells than the control chambers and, yet, there was no significant difference in the number of these cells among the three different radiation dose groups. In contrast, the number of plaque forming cells (PFC) decreased with increasing doses. These as well as earlier results strongly suggest that the decrease in the number of PFC was not primarily due to the killing of antibody-producing cells themselves but rather due to the inactivation of the antibody forming machinery (messenger RNA for specific antibodies, enzyme systems required for protein synthesis and/or the architectural site(s) for protein synthesis), or the inactivation of the machinery of antibody secretion. Studies on the comparative lethal effects of fast neutrons and x radiation on cells in mouse mammary tumors indicated that fast neutrons are advisable for the treatment of radioresistant tumors containing hypoxic cells. Thyroid tissues surgically removed from a limited number of patients with various thyroid disorders, including adenomas, carcinomas, and hyperthyroidism were analyzed for content of trace elements (Br, Cu, I, and Mn) following neutron activation. No indicative data were obtained. Calcium kinetics were studied in patients with various bone disorders by measuring the time course of ^{47}Ca concentrations after a single injection and fitting the curves thus obtained to exponential function data. Chromosome abnormalities persisting in bone marrow cells of 13 irradiated humans were examined for possible evidence of the establishment or the maintenance of clones in the bone marrow. No conclusions were reached. (C.H.)

16307 (ORO-678) ANNUAL PROGRESS REPORT, JANUARY 1–DECEMBER 31, 1969. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Sep 1970. Contract AT-40-1-GEN-242. 154p. Dep. NTIS.

Twenty-three articles are included; separate abstracts were prepared for 21. The remaining two articles contain information on mineral content of hair as a possible indicator of disease of nutritional origin and properties of clay systems controlling ion exchange kinetics and ion exchange equilibrium. (P.C.H.)

For abstracts of individual papers see: 15728, 15764, 16000–16002, 16026, 16091, 16308–16320, and 16376.

16308 (ORO-678, pp 4-6) SOMATIC CHANGES IN THE FETUS. Murphree, R. L. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1–December 31, 1969.

Rats were exposed to 100 R γ radiation given in dose-rates of 1, 2, 3, 4, 5, 10, and 47 R/min on the eleventh day of gestation. It was found that dose rates of 3 to 10 R/min caused significantly more eye damage than any other rate. Data from a study of effects of dose rates of 1, 3, 10, 25, and 47 R/min (dose 50 R) given on the 20th day of gestation on testicular damage were analyzed. Histological analyses of the testes taken at 28, 70, and 91 days after birth revealed that the 10 R/min rate was more damaging than any other dose rate. Groups of 15 to 18 ewes were exposed to dose rates of 0.3, 0.7, 1, and 47 R/min (dose 200 R) on the 23rd day of gestation. Additional groups of nine or ten ewes were exposed to the same total dose at 1 R/min on the 17th to 22nd days of gestation to determine if other types of abnormalities than those of the legs might be produced. Nineteen ewes died subsequent to irradiation; 18 of these exhibited a hemorrhagic syndrome. A table is presented to show the frequency of deformed lambs born to ewes exposed at the different rates on the 23rd day of gestation. (H.L.W.)

16309 (ORO-678, pp 7-13) EFFECTS OF PRENATAL IRRADIATION ON GROWTH. Martin, Polly G. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1–December 31, 1969.

Effects of γ radiation on growth of rat liver, kidney, spleen, and thymus were observed between birth and 160 days following prenatal exposure. The response was similar to the adult recovery patterns but did not attain control levels in total DNA (cell numbers) although growth as a result of hyperplasia was prolonged. A

multiple regression for estimation of DNA in the four organs studied was determined with organ weight and organ age used as the variable. Initial work on the growth pattern of two areas of the brain indicated that the cortex from the irradiated rats was severely affected in cell numbers. Experiments in which growth hormone was injected into prenatally irradiated rats and controls resulted in increased body weights of the irradiated animals but not the controls. Increased weights of four organs investigated were caused by greater amounts of protein, RNA, and DNA in the tissues. (H.L.W.)

16310 (ORO–678, pp 25-7) EFFECTS OF RADIATION ON THE REPRODUCTIVE SYSTEM. Erickson, B. H. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1–December 31, 1969.

Hereford bulls, with the anterior one-third of their bodies shielded by lead plates and varying in age from one to 95 days, were exposed to ^{60}Co γ radiation in a multipoint field. Testicular doses varied in magnitude from 82 to 220 Rads and exposure rates varied from 0.4 to 50 R/min. In age groups of 20 to 30 days, germ cell numbers were reduced to 21% of controls. At ages from one to 60 days, the level of germ cell survival did not differ. Doses of 210 to 220 Rads, administered at 0.4, 1, and 50 R/min to the day 60 testis produced equally deleterious effects on the germ cells. Effects of exposure and exposure rates on follicular development and reproductive capacity in the prepubertal rat were studied. By 70 days postirradiation, numbers of primordial follicles had declined to 0.1 to 3% of controls. Females exposed to 200 R and unilaterally ovariectomized at ten days postirradiation produced 19% fewer pups than control and 43% more than the 400 R group. (H.L.W.)

16311 (ORO–678, pp 28-34) LIFETIME REPRODUCTION HERD. Reynolds, R. A. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1–December 31, 1969.

A herd of Hereford cattle was established to observe the effects of whole-body irradiation on the lifetime fertility of the survivors, the viability and growth rate of progeny of the survivors, latent pathological changes in survivors, and performance of the progeny by sire groups. The animals selected were females, 18 to 20 months of age at the time of irradiation. The 30 day mortality rate was 3% following 300 R γ radiation, 4% following 400 R, and 35% following two exposures of 300 R each. No observable differences in fertility were found between the irradiated and control groups and the viability of offspring was acceptable for all groups. The growth rate of progeny of irradiated dams and controls was identical each year at weaning. There was a strong trend toward increased death loss in irradiated survivors; the most prominent causes of mortality were vaginal prolapse, dystocia, and squamous cell carcinoma of the eye. (H.L.W.)

16312 (ORO–678, pp 35) PATHOLOGY REPORT ON LONG-TERM SURVIVORS OF IRRADIATION. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1–December 31, 1969.

A detailed list of pathological changes observed at autopsy of each of four cattle is presented. One had not been irradiated and three had received total body γ radiation. (H.L.W.)

16313 (ORO–678, pp 36-40) LATE EFFECTS OF IRRADIATION IN LARGE ANIMALS. Brown, D. G.; Johnson, D. F. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1–December 31, 1969.

Burros were exposed to single doses of ^{95}Zr-Nb in 1954, ^{182}Ta γ radiation in 1951, and multiple doses of ^{60}Co γ radiation in 1954. The dose range was 320 to 545 R. Cumulative mortality ranged from 10% in controls and the 320 R group to 70% in the 545 R group. Deaths were associated with blood dyscrasias, enteritis, loss in body weight, nephritis, and internal hemorrhage. A group of 32 four and one-half month old burros were exposed to a single dose of γ radiation in 1963 and 1964. The cumulative mortality was 26 and 28% in the nonirradiated and irradiated groups, respectively. Infections of the lungs and gastrointestinal tract were the common cause of death. A group of 33 burros were exposed to 230 to 510 Rads of neutron-γ radiation in 1957. Deaths were associated with loss in body weight, thrombocytopenia, leukopenia, anemia, enteritis, and internal hemorrhage. A group of five burros were exposed to 180 Rads of neutron-γ radiation from a Godiva type reactor in 1959; the only clinical manifestation apparent is graying of hair. (H.L.W.)

16314 (ORO–678, pp 41-6) LATE EFFECTS OF WHOLE-BODY GAMMA IRRADIATION ON THE WORK PERFORMANCE AND RELATED PHYSIOLOGY OF SHETLAND PONIES. Brown, Daniel G. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1–December 31, 1969.

Sixteen male ponies of the same age were trained to work and paired in teams of two on the basis of weight, temperament, and behavior. At 2.5 years of age, one pony of each team was exposed to whole-body γ radiation in exposures of 50 R/wk to a cumulative dose of 650 R. The work schedule was begun 150 days after the last radiation exposure. Five teams are subjected to work five days per week, and the remaining three teams are kept in exercise lots. The work load is generated by the braking effect of a hydraulic motor attached to the wheel supporting the apparatus which each team pulls. Results are presented for effects of radiation on heart rate, respiratory rate, and rectal temperature. The heart rate of the irradiated animals was slower than that of controls during work with a recovery rate equal to or faster than the controls. The respiratory rate of the irradiated animals was higher than the controls during the summer months, but during the winter months the rate was similar and sometimes lower in the irradiated animals. At the end of work the rectal temperatures of the irradiated ponies were usually higher than those of controls. (H.L.W.)

16315 (ORO–678, pp 47-8) TISSUE CULTURE. McFee, A. F. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1–December 31, 1969.

The peripheral leukocyte system of swine was chosen for studies on effects of radiation on a single cell system. Parameters chosen for study were changes in cell number, cell type, and viability; rates of DNA synthesis and mitosis; chromosome aberrations; and changes in nuclear volume during culture. Emphasis is placed on comparing cells irradiated in vivo with those exposed in vitro. One group of swine was exposed to 300 R γ radiation; this dose depressed leukocyte counts to the point where cultures could not be obtained between one and 12 weeks postexposure. A second group was exposed to 150 R and cultures from these animals were of sufficient quality to analyze. Swine blood samples were exposed to x ray and fission spectrum neutrons simultaneously with human samples for comparative studies. (H.L.W.)

16316 (ORO–678, pp 49-50) SUBSTANCES FORMED BY IRRADIATION ACTION ON ANIMALS. Souto, J. C. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1–December 31, 1969.

Experiments were begun on analysis of urine of irradiated animals and man for fatty acids. Carbon-14 is being used as a tracer for analytical recovery of fatty acids. Calibration of gas chromatograms by both straight chain fatty acids and standard branched chain fatty acids is being contemplated. (H.L.W.)

16317 (ORO–678, pp 51-7) CORRELATION OF DEPTH DOSE DISTRIBUTION PATTERNS WITH BIOLOGICAL EFFECTS IN SWINE FOR ^{60}Co GAMMA RAYS, 14 MeV NEUTRONS, AND FISSION NEUTRONS. Wade, Leo Jr.; Brown, D. G. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1–December 31, 1969.

Data from $LD_{50/30}$ studies in swine exposed to ^{60}Co, fission neutrons, and 14 MeV neutrons were examined for correlation with depth dose patterns. An estimate of the average dose to the bone marrow was made. Following intravenous injection of ^{59}Fe-labeled ferrous citrate it was found that the major sites of bone activity were the ribs and vertebral column. Using this distribution and depth dose data, an average bone marrow dose was calculated for animals receiving an $LD_{50/30}$ of each type of radiation. An average tissue dose across the maximum thickness of the animal was also calculated. Calculations were made for LET distributions of the absorbed dose at the midline of animals exposed to 14 MeV neutrons and fission neutrons mixed with γ rays. Calculations were also made for RBE of γ, 14 MeV neutrons, and fission neutrons. Results are presented in the form of tables and graphs. (H.L.W.)

16318 (ORO–678, pp 58-64) SIMULATED FALLOUT RADIATION EFFECTS ON LIVESTOCK. Bell, M. C.; Sasser, L. B.; West, J. L. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1–December 31, 1969.

The feeding of ^{90}Y-labeled sand at the rate of 2.4 mCi/kg of body weight to sheep was the major contribution to early deaths especially when combined with whole-body γ irradiation. Necropsy of sheep showed that the major damage was in the rumen sacs and in the abomasum. Irradiation of the skin using ^{90}Sr-^{90}Y sources had no effect on feed intake but the sheep weighed 15% less than controls within 50 days. Whole-body γ exposure of 240 R had no effect on feed intake or weight change but this level did reduce blood platelets and white blood cells. When combined with gastro-

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intestinal β radiation, it was lethal to almost half of the animals. The three types of radiation had little effect on mortality when given singly but when the three were combined, four of eight sheep died within 60 days. Research on cattle using essentially the same treatments was initiated. Preliminary data indicate that sheep are good models for cattle. (H.L.W.)

16319 (ORO-678, pp 65-73) PATHOLOGY REPORT. Johnson, D. F.; West, J. L. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1-December 31, 1969.

Necropsies were performed on 43 cattle, two burros, 45 sheep, and 32 swine. Of these, 28 cattle, one burro, 23 sheep, and six swine were long-term survivors of ionizing radiation or controls for such experimental animals. Pathological manifestations are listed for each animal. (H.L.W.)

16320 (ORO-678, pp 78-82) RADIOIODINE AND DAIRY CATTLE. Miller, J. K. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1-December 31, 1969.

Nine heifers were given ^{131}I in the following dose levels: 105, 156, and 176 μCi ^{131}I/kg body weight. Subsequent performance of each thyroid damaged animal was expressed as a percentage of her control twin. Thyroid activity and performance measurements of the two higher dose levels averaged nearly the same while distinctly less damage resulted from the lowest dose. Following thyroxine and thyroprotein replacement therapy, milk yields of thyroid damaged cows averaged only 62% of control during the last 38 weeks of lactation. Thyroid damaged cows averaged 3% heavier than controls, but after initiation of thyroprotein feeding, weight remained constant. Heart rates of thyroid damaged cows increased from less than 90% of control to over 110% during the first 38 weeks of thyroprotein feeding. Following injection of thyroid stimulating hormone into thyroid damaged cows, it was found that TSH had little effect on secretion of radioiodine into milk. Experiments were conducted on absorption and secretion of ^{125}I and ^{131}I by the calf abomasum; results suggested a competition between the thyroid and abomasum iodine concentrating systems. Rats, pigs, and cows were used for studies on effects of thyroid status on calcium metabolism. Animals with ^{131}I-damaged thyroids showed decreased ability to clear intravenously administered stable or radiocalcium. (H.L.W.)

16321 INFLUENCE OF X RAYS ON THE HEALING OF FRACTURES. Woodard, Helen Quincy (Sloan-Kettering Inst., New York). Health Phys.; 19: 791-9(Dec 1970).

The tibias of adolescent female mice were irradiated either 21 days before or 10 days after fracture. The exposure dose was 2000 R; the absorbed dose was from 2180 to 2620 rad. The mineral content, ^{89}Sr uptake and alkaline phosphatase activity of the irradiated or nonirradiated fractured tibias were compared with the contralateral normal bones for periods up to 5 months with a few observations at 1 yr. These metabolic parameters were greatly increased by fracture. Irradiation of the established callus depressed its metabolism but not enough to prevent functional healing. Irradiation of the intact bone prior to fracture resulted in delay in activation of the repair process and in delayed and incomplete healing. The effect of irradiation before fracture was about twice as great as that after fracture. (auth) (UK)

16322 EFFECT OF IRRADIATION BY OPTICAL QUANTA GENERATORS ON THE SKIN OF THE NECK AND LARYNGEAL TISSUE OF WHITE RATS. Kolomiichenko, A. I.; Pokotilenko, A. K.; Timen, G. E.; Zhelyazo, N. S. Zh. Ushnykh Nosovykh Gorlovykh Bolez.; 28: 40-7(Nov-Dec 1968). (In Russian).

The results are presented of pathohistological investigations of the skin of the neck and underlying tissues, cartilages and mucous membranes of the larynx in albino rats subjected to radiation of lasers operating on a ruby (wavelength 6943 Å) and neodymium-activated glass (wavelength 10600 Å), with energy of 10 to 70 J per pulse. The data presented embrace the results of acute experiments conducted on 143 animals. Microscopic examinations of the skin, larynx and esophagus revealed changes in the skin only. The changes depend on the energy, number of pulses and were characterized by coagulation necrosis of the surface layers of the skin at a depth enclosing the region of the appendices. Deep-lying dermal layers were in a state of profound dystrophy and parabiosis. Direct irradiation of the laryngeal cartilages was attended by coagulation necrosis with prolapse of necrotic masses. Hyperemia and focal hemorrhages occurred in the mucous membrane and muscles of the larynx adjoining the inner surface of the irradiated cartilage. On irradiating the mucous membrane of the larynx through a laryngeal fissure, it coagulated in the region of radiation effect. On the periphery the coagulation phenomena gave way to disorganization of the mucous membrane, parabiosis and dystrophy. The data on changes in the tissues depending on the time elapsed after the action of the radiation will be published in the following communication. (auth)

16323 INVESTIGATION OF CONDITIONED-REFLEX ACTIVITY IN ANIMALS (ALBINO RATS) SUBJECTED TO THE EFFECT OF ULTRASHORT AND SHORT RADIO WAVES. Lobanova, E. A.; Goncharova, A. V. (Inst. of Labor Protection and Occupational Disease, Moscow). Gig. Tr. Prof. Zabol.; No. 1, 29-33(Jan 1971). (In Russian).

Results of a functional study of the higher divisions of the central nervous system in animals exposed to a chronic irradiation with ultra-short and short radio-waves (with electric field tensions of 150 and 2250 V/m respectively) are presented. An elevated excitability of the brain cortex under the effect of ultra-short waves and weakening of basic nervous processes over a space of 2 months during the short wave action were brought to light. This difference can hardly be explained by the peculiarities of the biological action exerted by ultra-short and short radio-waves, since the intensities applied were dissimilar. (auth)

16324 MAINTENANCE OF OVINE CORPORA LUTEA IN THE ABSENCE OF OVARIAN FOLLICLES. Karsch, F. J.; Noveroske, J. W.; Roche, J. F.; Norton, H. W.; Nalbandov, A. V. (Univ. of Illinois, Urbana). Endocrinology; 87: 1228-36(Dec 1970).

Experiments were conducted to determine whether ovarian follicles play a role in regulating the life span of the ovine corpus luteum. Destruction of follicles by x-irradiation of ovaries increased the efficacy of continuous infusion of purified LH to prolong the life span of the corpus luteum of the anatomically intact ewe. When follicles were present, the amount of infused LH required to maintain corpora lutea was 4 times greater than that needed when follicles had been destroyed. Infusion of 300 μg LH/day/ewe maintained fully functional corpora lutea provided no rapidly growing follicles were present; this dose increased the concentration of LH in serum by less than 2 ng/ml. The pattern of spontaneous luteal regression in ewes whose follicles were destroyed differed significantly from the abrupt luteal regression which occurred between days 15 and 17 after heat in nontreated cyclic ewes. In the absence of follicles, corpora lutea regressed gradually, and luteal degeneration was nearly complete by day 20. It was concluded that ovarian follicles, and thus follicular estrogen, are not required for maintenance of the corpus luteum of the ewe. Furthermore, it is suggested that follicles may compete with corpora lutea for luteotrophin, and that the preovulatory maturation and development of follicles play a role in instigating the demise of the corpus luteum of the cyclic ewe. (auth)

16325 ROLE OF CHALONE IN THE CONTROL OF THE BONE MARROW STEM CELL POPULATION. Kirk, J. (Western Regional Hospitl Board, Glasgow); Orr, J. S.; Forrest, J. Math. Biosci.; 6: 129-43(1970).

The bone marrow stem cell population is a basic undifferentiated self-maintaining population that supplies the three main circulating blood populations. The mitotic replenishment of the stem cells under the control of their specific mitotic inhibitor, chalone, forms the system under discussion. The mathematical formulation of this system was presented as two nonlinear simultaneous differential equations. These equations were solved with the aid of an EAL 680 analogue computer, giving an exact solution by continuous integration. The behavior of the mathematical formulation was compared with the experimental results for the recovery of the stem cell population in polycythemic mice after x-irradiation. Under various conditions, different forms of oscillatory solution were found, and the forms of these solutions were examined by sensitivity analysis. The agreement of the formulation with the experiment was shown to be unsatisfactory unless the concept of a controlled variable cycle transit time was invoked. This effect could be of great importance in the stability of the sequence and timing of the control mechanisms of more complex systems. (auth)

16326 USE OF CHEMOSTERILANTS, SEX HORMONES, RADIATION, AND HYBRIDIZATION FOR CONTROLLING REPRODUCTION IN TILAPIA SPECIES. Al-Daham, Najim Kumur. Auburn, Ala.; Auburn Univ. (1970). 176p. University Microfilms Order No. 70-22,269.

Thesis.

Four different methods for controlling reproduction in Tilapia spp. (Cichlidae) were investigated, and their effects on sex ratio, fertility, survival, and growth were evaluated. These were chemosterilization, sex hormones, irradiation, and hybridization. Specimens of T. aurea were treated with different concentrations of

metepa, tris (2-methyl-1-aziridinyl) phosphine oxide, and tetramine, 2,4,6-tris (1-aziridinyl) s-triazine, for different periods. After treatment the fish were raised in plastic pools. Metepa inhibited brood production for 3 months and tetramine for 2 months when used at concentrations of 20 and 0.8 ppm, respectively. Histological changes induced by metepa included degeneration of the seminiferous tubules and swelling of the remaining tubules, and a reduction in number of oocytes in ovaries. T. aurea were treated with two sex hormones, testosterone and diethylstilbestrol, during gonadal differentiation. A sex ratio of 89% males was obtained when they were treated with 0.4 mg/l testosterone for a 12-day period, indicating that a degree of sex reversal was achieved. An improvement in female size was also observed. T. aurea fry were irradiated with doses ranging from 83 to 6,384 roentgens of cobalt-60 gamma-rays, and subsequently raised in pools. The results showed reduction in both gonadosomatic index and growth rate with increase in dosage. The 30-day LD_{50} was 2,000 roentgens. T. hornorum was crossed with T. aurea and with T. mossambica. The hybrids were raised in plastic pools, concrete pools, and earthen ponds. The highest percentage of males (84%) was obtained by crossing female T. hornorum x male T. aurea. Generally, all four hybrids showed higher survival rates and produced greater yields than their parent species. (Diss. Abstr., Int., B)

16327 RESTORATION OF THYMECTOMIZED IRRADIATED MICE BY FROZEN AND STORED THYMUS GRAFTS. Cheers, Christina; Leuchars, Elizabeth; Davies, A. J. S.; Wallis, Valerie (Inst. of Cancer Research, London). Transplantation; 10: 505-11(Dec 1970).

Adult thymectomized, irradiated, bone marrow-injected mice were grafted with fresh or frozen thymuses. Using CBA/H. T6T6 thymus grafts in CBA/H mice, it was possible to follow release of cells from the graft. After 3 weeks of storage at −150 C, using dimethyl sulfoxide as a preservative, the frozen thymuses fully restored the haemagglutinin titre to sheep erythrocytes and the mitotic response to oxazolone. Successful restoration of skin graft rejection and phytohaemagglutinin responsiveness was more variable. Possible mechanisms by which the frozen graft acted are discussed. (auth)

16328 FINE STRUCTURE AND PHYSIOLOGY OF THYMUS GRAFTS IN THE CHEEK POUCH OF THYMECTOMIZED, IRRADIATED HAMSTERS. Merk, Linda Poole. Boston; Boston Univ. (1970). 197p. University Microfilms Order No. 70-22,406.

Thesis.

A study was made of the histology and ultrastructure of thymic allografts in the cheek pouch of thymectomized, irradiated and untreated hamsters. Following thymectomy and sublethal total body x-irradiation, hamsters demonstrate a severe leukopenia and lymphocyte depletion in peripheral lymphoid organs. Thymic allografts in untreated hamsters, following an incomplete and temporary lymphocyte depletion, closely resemble in situ thymus histologically and ultrastructurally. An early increase in periodic acid-Schiff (PAS) positive cells is noted in lymphocyte-depleted grafts. Allografts in thymectomized, irradiated hamsters exhibit more extensive and prolonged lymphocyte depletion, and more PAS positivity. Cells containing granules, visible with the electron microscope, are more frequent in young thymus grafts than in situ thymus, and cells containing large amounts of smooth endoplasmic reticulum are more common in grafts from thymectomized, irradiated hosts. Heterografts of Armenian hamster thymus in untreated as well as thymectomized, irradiated Syrian hamsters take temporarily and provide a convenient chromosome marker. Chromosome counts indicate that donor mitotic cells are replaced by host cells at a nearly exponential rate, but replacement does not reach completion in the time interval studied. Replacement is more rapid in stressed hosts. From the above observations it is suggested that an intrathymic demand for lymphocytes occurs within grafts in untreated hosts due to the temporary lymphocyte depletion, resulting in increased numbers of granule-containing reticular cells. Grafts located in thymectomized, irradiated hosts may express an extrathymic demand for lymphocytes by an increase in reticular cells containing dilated smooth endoplasmic reticulum cisternae. The more rapid replacement of donor cells by host cells in the stressed animals may reflect the greater demand on the part of the stressed host for competent lymphocytes. (Diss. Abstr. Int., B)

16329 ^{90}Sr-INDUCED OSTEOSARCOMAS IN RADIATION CHIMAERAS. Barnes, D. W. H.; Carr, T. E. F.; Evans, E. P.; Loutit, J. F. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol.; 18: 531-7(1970).

To determine whether sarcomata of bone are derived from osteo-progenitive cells committed to bone production or from uncommitted pluripotent cells in bone-marrow, radiation chimeras were injected intraperitoneally with 20 μCi of strontium-90. Both syngeneic CBA/CBA−T6T6 and allogeneic CBA−T6T6/A chimeras were used. The resulting tumors were analysed cytologically for T6 chromosomes to determine whether they were of host or donor origin. The aneuploid cells of all 13 tumours analysed were of host-type: this was confirmed by genetic analysis in six tumors arising in allogeneic chimeras. Euploid mitotic cells of donor marrow provenance were commonly seen in preparations of tumors. Tumors were also analysed in 11 of 14 normal mice, both CBA and CBA−T6T6, injected with 20 μCi of strontium-90. No false positive or false negative results for T6T6 were recorded. The bone-tumors were of at least two types, typical osteoblastic sarcomata and osteolytic sarcomata either fibroblastic or haemangioendotheliomatous. (auth) (UK)

16330 RADIATION EFFECTS ON EMBRYONIC CHICK TIBIAE. Mawhinney, B. S. (Univ. of Iowa, Iowa City). Experientia; 26: 1245-6(15 Nov 1970).

The effects of x radiation on the development of tibiae in embryonic chicks were investigated. The time in which the developing chick tibiae were most radiosensitive was also observed. (P.B.M.)

16331 DIFFERENTIAL NEURONAL RADIOSENSITIVITY AS A TOOL FOR THE STUDY OF SHORT CONNECTIONS. de Estable-Puig, Rosita F.; Estable-Puig, J. F. (Laval Univ., Quebec). Experientia; 26: 1250-1(15 Nov 1970).

Rats were given a 20,000 R dose of x radiation to the head with the body shielded. Twenty-four hrs later the brains were excised and the olfactory bulbs were processed for electron microscopy observation. Degenerating terminal endings of the electron dense type were observed at the level of the plexiform layer, in synaptic contact with ramifications of the accessory dendritic branches of the mitral cells. It is proposed that this method represents a valuable tool for the study of short neuronal connections in certain regions of the central nervous system. (H.L.W.)

16332 X-IRRADIATION AND THYROID ACTIVITY IN A TELEOST, MYSTUS VITTATUS (BLOCH). Singh, T. P. (Banaras Hindu Univ., India). Experientia; 26: 1261-2(15 Nov 1970).

Varying doses of x rays were administered to the pharyngeal area containing the thyroid follicles of 210 adult catfish (Mystus vittatus). At intervals of 1, 2, 3, and 4 months the thyroid activity was studied. It was found that the rate of reduction in thyroid activity was directly proportional to increasing doses of x rays as evidenced by ^{131}I uptake. Significant damage to thyroid tissues became apparent at 60 days after irradiation. (H.L.W.)

16333 EFFECT OF BONE MARROW HYDROLYZATE ON THE SURVIVAL OF LETHALLY IRRADIATED RABBITS AND ON SOME HEMOPOIETIC INDICES. Gankevich, G. A.; Shostka, G. D.; Kanaev, S. V.; Chaplygina, Z. A. (Inst. of Medicine, Leningrad). Probl. Gematol. Pereliv. Krovi; 15: No. 6, 36-9(Jun 1970). (In Russian).

The effect of the preparation of the split rabbit bone marrow on some hemopoietic indices in rabbits after a single total x-ray irradiation (1,000 I) was studied. Bone marrow hydrolysate produced no side-effects and diminished the mortality of irradiated animals, particularly in the series of experiments in which it was used against the background of detoxication therapy. (auth)

16334 CONTRASTING PATTERNS OF SPLENIC AND MEDULLARY HEMATOPOIESIS. Thomas, D. Brynmor (Medical School, Birmingham, Eng.). Exp. Hematol.; No. 20, 121-3(1970).

Myeloid metaplasia in the spleen of the radiation chimera results in the establishment of a cell population which differs from that in the regenerating bone marrow. These differences should be borne in mind in experiments which utilize splenic regeneration in the radiation chimera. For a given number of erythroblasts, the bone marrow contains seven times as many granulocytes as the spleen. The difference in the degree to which the granulocytopoietic potential of the repopulating cells is expressed in the spleen and in the bone marrow is attributed to differences in the hematopoietic microenvironments provided by these two sites. (auth)

16335 FORECASTING THE EFFECT OF IRRADIATION OF ANIMALS. Graevskaya, B. M.; Nechaev, I. A.; Zolotareva, N. N. (Inst. of Biological Physics, Pushchino, USSR). Dokl. Akad. Nauk SSSR; 189: 655-8(21 Nov 1969). (In Russian).

Certain features of the carbohydrate and protein metabolism of mammals are related to their radiosensitivity. In order to analyze the individual differences in radiosensitivity, it was attempted to evaluate the carbohydrate metabolism on the basis of the sugar level in the peripheral blood, examining the reaction of this indi-

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cator to the introduction of adrenalin. The rate of proteolytic processes in the whole blood was also studied, using the number of leucocytes as indicator. The male rats were exposed to 500 to 675 R of x radiation, comparing the outcome after one month, namely death or healing, with the empirically calculated expectations. Of the 38 cases, the outcome of the irradiation was correctly predicted in 30 cases, corresponding to a probability of 0.79 ± 0.07. Thus, tests carried out during the lifetime of the animals are able to indicate the viability of the organism and could be used to predict the outcome of individual radiation injuries. In about 20% of the cases the data were unclear and did not allow exact prognosis. (TTT)

16336 OSCILLATORY NATURE OF HEMOPOIESIS. Morley, Alec; King-Smith, Eric A.; Stohlman, Frederick Jr. (Tufts Medical School, Boston. Univ. of Michigan, Ann Arbor). pp 3-14 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

The oscillatory nature of hemopoiesis is discussed. It seems unlikely that the control features shown by hemopoiesis are unique. The most important principles are as follows. The steady state borders on oscillation. This setting provides the best compromise between sensitivity and stability. This setting can often be achieved by combining a high gain production loop with a large capacity release loop. The production loop provides sensitivity (although after a delay) and the capability of indefinite response. The release-rate loop provides immediate response and stability. For most biologic systems it is more important to react vigorously in one direction, then another. The production loops of many systems may therefore operate on an inflection of their input–output curve and a small movement in the critical direction may move the system into a high gain region with consequent enhancement of rhythmicity. The abortive rise in erythropoiesis in animals following irradiation may be a manifestation of the oscillatory nature of hemopoiesis. Finally, if many systems do show the same principles of control as does hemopoiesis, many periodic diseases may arise in a similar fashion to periodic diseases of hemopoiesis. (F.M.M.)

16337 CELLULAR INTERACTIONS IN THE CONTROL OF HEMOPOIESIS. McCulloch, E. A.; Till, J. E. (Univ. of Toronto. Ontario Cancer Inst., Toronto). pp 15-25 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

The growth of bone marrow from C57Bl/6 (B6) mice in irradiated F_1 hybrids was investigated and the genetic basis of the resultant poor growth was discussed. The effects of treating recipients with cyclophosphamide prior to irradiation and marrow injection were also studied. It was shown that the addition of F_1 thymus cells, heavily irradiated F_1 marrow or spleen cells resulted in an increase in colony formation by B6 cells in irradiated, cyclophosphamide treated F_1 mice. An hypothesis was made relating the H2 antigen to a specialized region of the cell surface and its role in cellular interactions in the regulation of hemopoiesis was discussed. (F.M.M.)

16338 RELATIONSHIP OF THE THYMUS TO ERYTHROPOIESIS. Goodman, Joan Wright; Grubbs, Chareen G. (Oak Ridge National Lab., Tenn.). pp 26-35 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

Parental thymocytes given to irradiated F_1 hybrid mice along with parental bone marrow increased the numbers of all kinds of hemopoietic colonies in the spleen. Colonies appeared earlier and grew more rapidly in these chimeras than in recipients of marrow only. When recipient mice were splenectomized two weeks before irradiation, the potentiating effect of thymocytes was not seen. Thymectomy of recipients, on the other hand, did not change the outcome of the experiment. (auth)

16339 HEMATOPOIETIC STEM CELL COMPARTMENT: PATTERNS OF DIFFERENTIATION FOLLOWING RADIATION OR CYCLOPHOSPHAMIDE. Hellman, Samuel; Grate, Helen E.; Chaffey, John T.; Carmel, Richard (Harvard Medical School, Boston). pp 36-48 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

The granulocytic and erythrocytic repopulating ability of bone marrow were compared and contrasted following in vivo treatment of this marrow with either x ray or cyclophosphamide. X-ray resulted in a lower survival fraction for the erythrocytic repopulating ability but, following a marked postirradiation dip, there appeared more prompt recovery. Such data appeared best explained by assuming that the radiation not only resulted in cell kill but also affected the pattern of differentiation of the reduced population of the stem-cell compartment. Cyclophosphamide showed further increased sensitivity of erythrocytic repopulating ability. This was explained by the apparent increased sensitivity of rapidly-proliferating cells to this drug. The results of these agents were used to construct a model of the early compartments of the hematopoietic system and to indicate what compartments appear to be measured by some of the stem cell assay procedures. (auth)

16340 RECONSTITUTION OF BONE MARROW IN A DEPLETED MEDULLARY CAVITY. Patt, Harvey M.; Maloney, Mary A. (Univ. of California, San Francisco). pp 56-66 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

Marrow restoration in the evacuated femur was examined by cytokinetic and histologic techniques in conjunction with radiation studies. The results of these investigations, along with the work of others, are as follows: The restoration of marrow in a mechanically depleted site is a local phenomenon in regard to both the stimulus for regeneration and the origin of the responsible cells. The regenerative process stems from mesenchymal cells in the connective tissue of the haversian canals. Development of the marrow structure depends upon subsequent interactions of these cells and their derivatives in a manner not unlike that after bone fracture. Trabeculization of the medullary cavity seems to be an important feature of the regenerative process, perhaps because it creates an environment or provides a source of progenitor cells or both. Mesenchymal cells can be quite radiosensitive as shown by an ED_{50} of about 400 R for delay of marrow restoration in an empty femur shaft. X irradiation with 1000 R has a greater effect on the just-evacuated femur than on the normal femur. However, when irradiation takes place 9 days after femur evacuation, even though there are few recognizable hemic cells, the response to 1000 R closely resembles that of intact marrow. Development of a fibrotic marrow after removal of normal marrow is a rare occurrence. Yet, the fact that it can occur suggests that an aberration of mesenchymal elements in bone may play an important role in the genesis of idiopathic myelofibrosis. (auth)

16341 MORPHOLOGIC AND CYTOKINETIC ASPECTS OF BONE MARROW STROMA. Fliedner, T. M.; Calvo, W.; Haas, R.; Forteza, J.; Bohne, F. (European Atomic Energy Community, Brussels. Nuclear Research Center, Karlsruhe, Ger.). pp 67-86 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

Investigation of the angio- and neuroarchitecture of the rat bone marrow indicates the delicate ecology of endothelial cells, reticular cells, bone marrow nerves, and hemopoietic cells. The angioarchitecture is characterized by a nutrient artery branching into many arterioles. The sinusoidal system can be described by a series of sinusoidal trees with a rectal sinusoid as the trunk and contortol sinusoids as branches supplied from the arterial side. The arteries and arterioles are accompanied by nerves, but many nerve fibers go straight through the parenchyma and by sinusoids. A hypothesis is advanced that fine regulation of hematopoietic proliferation and cell release is performed via nerve fibers that may be sensitive to minute pressure changes (pressure from hemopoietic growth and from blood flow), particularly in an organ that is protected from external pressure through a rigid bony capsule. The renewal characteristics of the cellular elements of the stroma (endothelial cells, reticular cells, marrow lymphocytes) were studied by the complete ^{3}HTdR labeling method. It was shown that the renewal of these elements slows down considerably during the first 4 to 6 weeks of life. After that time, these cells may divide under normal conditions perhaps not more than once a year. If cytotoxic stimuli are applied to the marrow (radiation, nitrogen mustard, hydroxyurea) it can be shown that endothelial cells and reticular cells do not participate in the hematopoietic regenerative activity of the marrow. However, the small round cell of the marrow, called marrow lymphocyte, appears to be able to respond to those stimuli with a burst of proliferative activity. If hydroxyurea was given four times 6 hours apart (500 mg/kg body weight per injection), a wave of labeled blast cells and subsequently differentiated myelocytic, erythropoietic and megakaryocytic cells was

found. It may be that these were derived from the labeled marrow lymphocyte population, that thus would have under normal steady state conditions all characteristics of a resting stem cell pool. (auth)

16342 EXPERIENCE WITH INJURED AND IMPLANTED BONE MARROW: RELATION OF FUNCTION TO STRUCTURE. Crosby, William H. (New England Medical Center Hospitals, Boston. Tufts Univ., Boston). pp 87-96 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

The effects of local and whole body irradiation on hemopoiesis in animals were reviewed and a relation between the bone marrow's sinusoidal microcirculation and hemopoietic function suggested. Experiments on marrow transplantation to other organs were described and it was shown that the vascularity of the host organ modified the eventual structure of the implant. It was observed that a sinusoidal structure must first develop before hemopoietic cells appear. The causes of aplastic anemia were discussed in relation to either inadequacy of the hemopoietic cells or of the sinusoidal microcirculation of the bone marrow. (F.M.M.)

16343 MODE OF ACTION OF ERYTHROPOIETIN IN POLYCYTHEMIC MICE. III. THE DOSE RESPONSE CURVE. Kretchmar, A. L.; McDonald, T. P.; Lange, R. D. (Univ. of Tennessee, Knoxville). Contract AT(40-1)-3547. pp 150-9 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

A report is given of certain characteristics of the dose-response relation observed when erythropoietin (ESF) is injected into polycythemic mice and the suddenness of recovery of the ability of the animals to respond to ESF after injury to their hemopoietic system by physical agents such as drugs or x rays. A model is presented from which predictions can be made about the response to ESF in polycythemic mice. The experimental results were consistent with certain predictions that were made. (F.M.M.)

16344 MECHANISM OF ACTION OF ERYTHROPOIETIN IN RELATIONSHIP TO CELL CYCLE KINETICS. Morse, Bernard S.; Rencricca, Nicholas J.; Stohlman, Frederick Jr. (Tufts Medical School, Boston. New Jersey Coll. of Medicine and Dentistry, Newark). pp 160-70 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

In the animal with suppressed erythropoiesis, the committed stem cell is in cycle with a prolonged generation time, the consequence of a variable G_1. In mice treated with hydroxyurea and erythropoietin there is a shortening of G_1 and an increase in the rate of turnover of committed stem cells. The data are compared with the rates of recovery reported after the administration of cytotoxic agents and irradiation. Damage to the committed compartment appears to be in part repaired by the influx of pluripotential cells. The maintenance of homeostasis by the stem cell compartment is discussed in accord with these findings. (auth) (F.M.M.)

16345 RADIOSENSITIVITY OF THE HEMATOPOIETIC COLONY-FORMING CELLS OF THE MOUSE. Duplan, J. F. (Institut du Radium, Paris). pp 189-96 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

Studies were made on the changes of radiosensitivity of fetal liver and bone marrow colony-forming cells of mice when the cells in DNA synthesis were killed by a suicidal dose of tritium-labeled thymidine and when a significant number of bone marrow cells were triggered into the active cycle. The recipient mice were first x-irradiated and then given a suspension of hemopoietic cells that had been incubated with tritium-labeled thymidine. Spleen colony counts were later made and D_0 values determined. (F.M.M.)

16346 GROWTH PATTERNS OF HEMOPOIESIS DERIVED FROM FETAL LIVER TRANSPLANTED INTO HEAVILY IRRADIATED MICE. Kubanek, Bernhard; Rencricca, Nicholas; Porcellini, Adolfo; Stohlman, Frederick Jr. (Tufts Medical School, Boston). pp 205-10 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

Mice were treated with 800 R whole-body irradiation, then injected with either fetal liver cells or adult bone marrow cells. The growth of colony-forming units in the spleen and the recovery patterns of erythropoiesis were then compared. (F.M.M.)

16347 IN VITRO AND IN VIVO COLONY TECHNIC IN THE STUDY OF GRANULOPOIESIS. Rickard, K. A.; Shadduck, R. K.; Morley, A.; Stohlman, F. Jr. (Tufts Univ., Boston). pp 238-48 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

The relationship was considered between the in vitro and the in vivo colony technics and how they assist in the study of granulopoiesis. It was also shown firstly, that on the basis of a reduction in bone marrow in vitro colony-forming cells with hydroxyurea and secondly, because of the increase in bone marrow in vitro colony-forming cells in the shielded limb or irradiated leg shielded mice and thirdly, because of the comparable relationship between the numbers of in vitro colony-forming cells in fetal liver and bone marrow that the cell compartment giving rise to the in vitro colony is a primitive member of the granulocyte series, not the transplantable colony-forming unit, but more likely a committed myeloid stem cell that is in cycle. (auth)

16348 RESPONSES OF THE THROMBOCYTOPOIETIC SYSTEM TO PLATELET DEPLETION AND IRRADIATION. Ebbe, Shirley (Tufts Medical School, Boston). pp 285-98 of Hemopoietic Cellular Proliferation. /Stohlman, Frederick Jr. (ed.). New York; Grune and Stratton, Inc. (1970).

From Symposium on Hemopoietic Cellular Proliferation, Boston, Mass. See CONF-691107.

Platelet counts were done in rats after circulating platelets were depleted by exchange transfusion with platelet-poor homologous blood or rabbit anti-rat platelet serum. Counts were also made in mice after exposure to 300 R x radiation. The mice were made thrombocytopenic by an injection of antiplatelet serum either before or after irradiation, and the severity of the radioinduced thrombocytopenia was compared. It was confirmed that there is a homeostatic mechanism by which the level of circulating platelets influences the production of platelets. A model for megakaryocytopoiesis was presented. (F.M.M.)

16349 RADIATION EFFECT FROM LOW DOSES OF TRITIATED THYMIDINE. Payne, J. Thomas. Lawrence, Kan.; Univ. of Kansas (1970). 78p. University Microfilms Order No. 70-25,391.

Thesis.

Male Webster albino mice were given various doses (1, 10, 25, and 88 μCi per mouse) of ^{3}HTdR by gastric intubation. The following tissues were carefully dissected and weighed: small intestine (jejunum, ileum, duodenum), liver, testis, kidney, spleen, and muscle. These tissues were then freeze dried and digested by a chemical digest of either NaOH and methanol or tetraethyl-ammonium hydroxide depending upon the desired amount of tissue digest to be counted in liquid scintillation solution. External irradiations were performed with a 250 Maxitron x-ray generator (General Electric). Exposures used were 12.5, 25, and 50 R delivered to mice 20 days post-ingestion of a tracer dose of 3 μCi ^{3}HTdR. The arithmetic mean of non-volatile tissue activity from the assay of five mice was determined for each assay time period. Appropriate statistical tests were used to determine a difference in effect between or among different groups. In the small intestine and testis the rate of removal of the ^{3}H-label for the long-term component (30 to 90 days) was accelerated with increasing doses of 0.4, 1.0, and 3.5 μCi/gm of ^{3}HTdR in comparison with 0.04 μCi/gm. In the kidney and liver the rate of removal of the ^{3}H-label was independent of the quantity of ^{3}HTdR radioactivity administered. 25 R of x-rays produced the same rate of removal (1 to 16 days post irradiation) of the ^{3}H-label as 1 μCi/gm ^{3}HTdR in small intestine and 0.1 μCi/gm in testis. The retention of the ^{3}H-label in the kidney and liver was essentially unaffected by external x-rays up to 50 R. In the small intestine and testis there was a disproportionately smaller fractional retention of the ^{3}H-label with increasing radioactivity or increased external irradiation exposures, indicating the possibility of a saturation of the effect with increased levels of radiation damage. Since the doses of ^{3}HTdR used in this investigation were low in comparison with those generally considered sufficient to produce significant cell killing, it has been proposed that the reduced fractional retention of the ^{3}H-label with increasing quantities of radioactivity is the result of a repair and/or recovery process. (Diss. Abstr.) (TSS)

XUM

16350 RESPONSE OF NEWT LARVAE TO X IRRADIATION. Friedmann, G. B.; McCurdy, H. M.; Algard, F. T. (Univ. of Victoria, British Columbia). Can. J. Zool.; 48: 1017-21(Sep 1970).

Graded doses of from 200 to 2000 rad of x rays were administered to premetamorphic Taricha torosa larvae of various ages. General stunting, specific malformation, pigmentary damage, and a very shortened life-span occurred at all doses. There is an age-dependent dose response; some animals exposed to 200 and 600 rad survived to complete metamorphosis. Evidence is presented supporting a view that post-metamorphic epidermal melanocytes may be derived largely by division of an unpigmented progenitor cell type. (auth) (Canada)

16351 ROLE OF THE ADRENAL GLANDS IN THE CHANGE IN THE AMOUNT OF CERTAIN ELECTROLYTES OF HEART MUSCLE IN IRRADIATED ANIMALS. Sarukhanov, A. G. Zh. Eksp. Klin. Med.; 10: No. 1, 34-9(1970). (In Russian).

Irradiation of rats with 800 R resulted in a drop of the sodium content in the cardiac muscle, the content of potassium was not affected, and the content of calcium was reduced only on the fifth day following irradiation. The removal of the adrenal glands in non-irradiated rats resulted in labile changes in the electrolytic balance of the heart muscle that was related to the lack of control by the adrenal gland hormone. Considerable changes in the electrolytic balance and in the cation gradients of cardiac muscles were observed in adrenalectomized and irradiated rats. (R.V.J.)

16352 ROLE OF EMBRYONAL TRAUMA OF THE BRAIN IN THE ORGANIZATION OF EPILEPTIFORM ACTIVITY. Kolomeitseva, I. A.; Myslobodskii, M. S. Patol. Fiziol. Eksp. Ter.; 13: 12-18(Nov-Dec 1969). (In Russian).

EEG peculiarities and various forms of evoked responses of the optic cortex (thythmic response, sensory and convulsive afterdischarge and photomyoclonic reaction) in control and in x-irradiated rabbits (in a dose of 300 R) at the middle and at the end of embryogenesis were studied. The average number of waves of the aftereffect in the optic cortex in response to light stimulus, the dose of metrazol required for provoking the sensory afterdischarge and photoconvulsive reaction, and also the threshold of convulsive afterdischarges following direct stimulation were determined. Various forms of spontaneous and provoked by flickering light bilaterally synchronous and generalized were seizure potentials recorded in the animals irradiated during the middle of embryogenesis; a reduction of photometrazol thresholds was also noted. An opinion of centrasthenic genesis of epileptiform syndrome in animals, irradiated at the middle of embryogenesis is put forward. (auth)

16353 CHANGES IN SKIN HISTAMINE INDUCED BY X-RAY OF DIFFERING QUALITY. Carlsen, Ray A.; Asboe-Hansen, Gustav (Univ. of Copenhagen). J. Invest. Dermatol.; 56: 69-71(Jan 1971).

Rat skin was exposed in vivo to two types of superficially penetrating x ray (12 kV and 30 kV). Measurement of histamine levels and mast cell counts in the skin demonstrated the susceptibility of the cells to this type of radiation stimulus. Although 30 kV x ray produced the strongest effect, even 12 kV x ray (grenz) produced statistically significant changes. The measurable differences lasted more than 21 days. (auth)

16354 REACTIVITY OF THE ORGANISM AND RADIATION DAMAGE. Akopyan, S. A. (Erevan State Univ.). Biol. Zh. Arm.; 23: No. 4, 104-10(Apr 1970). (In Russian).

The effect of the functional state of an animal on its radiosensitivity is reviewed. Death rates were 20, 50, and 100% in adult mice kept before and after a 600-R irradiation at 5 to 8°, 20° and below 2° or above 37°C. In frogs, a temperature below 2°C improved resistance to radiation. Preliminary acclimatization of mice to 34-37°C increased their radiation resistance, but keeping them at 8 to 15°C after irradiation decreased it. Immature mice and frogs were relatively more resistant at low temperatures and less at high. Rabbits, fed on vegetables, had a higher death rate after irradiation than animals eating mixed diets. Hunger increased the reactivity of homothermic animals to radiation, and in hungry animals, loading with trace elements increased the death rate, but combined bone marrow and trace element treatment slowed the development of acute symptoms, and decreased their severity. Decrease in water increased radiation damage, and radiosensitivity was increased by drug stimulation of the sympathetic and parasympathetic nervous systems (adrenaline and acetyl choline). Removal of 30% of the bone marrow before or after irradiation of rabbits decreased their survival rate. (TTT)

16355 EFFECT OF COMPLEX COMPOUNDS OF COBALT AND IRON ON PROCESSES OF LIVER REGENERATION IN IRRADIATED ANIMALS. Nikolaev, A. I.; Mirzakarimov, T.; Seifullin, F. Kh.; Pulatov, R. P. (Tashkent Medical Inst.). Byull. Eksp. Biol. Med.; 70: No. 8, 98-102(Aug 1970). (In Russian).

In experiments on 245 albino rats subjected to x irradiation the effects of complex compounds of cobalt ^{30}Co and ^{35}Co coamid, and iron (ferrant) on the regeneration processes of the liver after partial hepatectomy were studied. Single whole-body irradiation of rats in a dose of 600 R caused a sharp suppression of the organ. The preparations, especially ferrant and ^{35}Co and coamid, are conducive to an accelerated restoration of the initial weight of the liver. Thus, in the group of rats treated with ferrant the initial weight of the organ restored on the 7th to 14th day. ^{35}Co and coamid, on the 14th to 30th day, ^{30}Co, on the 30th to 45th day, whereas in the group of nontreated rats on the 60th experimental day the liver weight comprised 96.3% of the initial weight. Thus, complex compounds of cobalt and iron with biologically active substances stimulated the liver regeneration in irradiated rats. (auth)

16356 SEVERAL FEATURES OF CONDITIONED REFLEXES FROM THE VISUAL ANALYZER OF DOGS SUBJECTED TO THE ACTION OF IONIZING RADIATION ON THE 20th DAY OF EMBRYOGENESIS. Arzumanov, Yu. L. Zh. Vyssh. Nerv. Deyateln. im. I. P. Pavlova; 18: 906-8(Sep-Oct 1968). (In Russian).

Antenatal effects of ionizing radiation on the function of the brain were studied using three month old puppies born from mothers exposed on the 20th day of embryogenesis to a single whole-body irradiation with 200 R. The results showed that x irradiation during the gestation period affected mainly the visual analyzer which was expressed in functional deficiency in developing positive and negative conditioned reflexes and inhibited the ability of making fine light differentiation. (R.V.J.)

16357 STUDIES ON THE EFFECTS OF VARIOUS SURGICAL STRESSES IN MICE EXPOSED TO IONIZING RADIATIONS SIMULATING NUCLEAR DETONATION. Hamada, Katsuhiro (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 11, 169-94 (1970).

Mice were exposed to a combination of fast neutrons, ^{60}Co γ radiation, and ^{89}Sr β radiation. Mice that recovered were subjected to various surgical stresses. The post-surgical survival rate was slightly lower among the irradiated than the non-irradiated. The post-surgical weight showed a moderate loss reaching its peak on the third day following surgery and subsequent recovery was inhibited. Marked disturbance in wound healing was noted in the irradiated group. A marked post-surgical leukocytosis occurred in the non-irradiated mice, but was very slight in the irradiated group. In general the findings indicated a decreased tolerance to surgical stress following irradiation. (H.L.W.)

16358 ELECTRON MICROSCOPIC HISTOCHEMICAL STUDY OF THE LYSOMOMES IN THE ABNORMALLY DEVELOPING EMBRYONIC HEART AND DERMAL CELLS IN THE RAT. Satow, Yukio; Okamoto, Naomasa; Ikeda, Takayoshi; Ueno, Takehisa; Miyabara, Sinichi (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 11, 90-103(1970). (In Japanese).

It was shown that irradiation of pregnant rats of the Donryu strain with 130 rads of 14.1 MeV fast neutrons 8 days after conception causes malformation of the heart and great vessels to occur in 85% of the fetuses. On the basis of this experiment rats were exposed to a single dose of 130 rads of whole-body irradiation 8 days after conception and embryos were removed at various stages for studies on abnormally developing embryonic cells. In the embryonic dermal cells, at 1 hour after irradiation, dilatation of nuclear envelopes, ER, and mitochondria were observed. After 2 to 3 hours vacuoles due to vacuolation around dense body, mitochondria, ER, and nuclear envelopes were increased. At 6 hours after irradiation 3 to 5 μ sized cytolysomes which show positive acid phosphatase activity by histochemical technique and contain vacuoles, degenerated mitochondria, and dense materials were frequently noticed. At 3 to 6 days after irradiation 0.5 to 1 μ sized autolysomes were increased in the myocardial cells and some of them develop to become 5 μ sized residual bodies which contain dense materials and degenerated organelles showing negligible acid phosphatase activity. About the endocardial cushion cells, autolysomes were also increased and contain myelin bodies, dense materials, and degenerated organelle. Small autolysomes, 0.5 μ-1.0 μ in size connect with small vesicles (Golgi vesicle, multivesicular bodies) topographically and some myelin bodies were being formed by membrane of the R-ER. Histochemical findings show that the large residual bodies in myocardial and endocardial cushion cells indicate negative acid phosphatase activities suggesting that these residual bodies were indigestible and are related to

developmental retardation and decrease the number of the cells after irradiation of this organ. (auth)

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Refer also to abstracts 15987, 16010, 16011, 16013, 16014, 16016, 16059, 16105, 16134, 16152, 16187, 16189, 16194, 16197, 16204, 16213, 16215, and 16266.

16359 (AD-710375) CLOSED CIRCUIT TELEVISION APPLICATIONS IN REACTOR RADIATION BIOLOGY RESEARCH. Millbranth, D. R. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Jul 1970. 17p. (AFRRI-TN-70-1). NTIS.

Closed circuit television provides the investigative staff with visual and aural communications in research using the AFRRI-TRIGA reactor. The report describes the television system in its applications to research support and documentation, and in reactor operations safety. (auth) (USGRDR)

16360 (JPRS-51641) SPACE BIOLOGY AND MEDICINE. VOL. 4, NO. 4, 1970. Translation of Kosm. Biol. Med.; 4: No. 4, 3-90(1970). 132p. NTIS.

Papers within the scope of NSA were previously abstracted from the original language. (H.L.W.)

16361 (JPRS-52274) SOME GENERAL CHANGES IN THE BODY PRODUCED BY LASER RADIATION. Semenov, A. I.; Syngaevskaya, V. A. Translated from Gig. Tr. Prof. Zabol.; [14:] No. 3, 9-12(1970). 4p. NTIS.

Results are reviewed from studies on the effects of laser radiation on rabbits and observations on personnel who work with lasers are summarized. It is concluded that exposure to laser radiation may cause injuries to the eyes and also systemic functional changes whose depth and intensity vary both with the irradiation parameters and with environmental conditions that prevail when the laser sources are operated. (C.H.)

16362 IMPAIRMENTS OF GUSTATION AFTER RADIATION THERAPY IN THE HEAD AND NECK REGION. Werner, H. (Univ., Kiel). HNO; 18: 133-6(1970). (In German).

One hundred and eleven patients with malign tumors in the head and neck region were examined after radiation therapy with special regard to gustation. Impairment of gustation especially occurs when radiation involves the tongue directly, but is less often found when the tongue is not located within the irradiated area. Objective findings explain the patients' complaints. The loss of the sense of taste is caused by a local reaction to radiation of the lingual area. A permanent loss of gustation was not found. Loss or impairment of olfaction or sensibility could not be observed. (INIS)

16363 STUDIES OF THE ERYTHEMA EFFECT CURVE. Fetz, Stephan (Univ., Zurich). Strahlentherapie; 140: 236-42 (Aug 1970). (In German).

The minimal energy dose was determined, after irradiation in 23 persons, which resulted in a naked-eye visible erythema after 24 to 48 hours. The irradiation was done on the unpigmented skin of the volar and ulnar side of the forearm, and with a light source Xenon XBo 900 WP, with a rectifier. The irradiation was done through a Carl-Zeiss Prismmonochromator M4 QIII with a suprasil-prism. The energy was measured by a compensated thermocouple Kipp & Sons' microgalvanometer. (auth)

16364 IRRADIATION-INDUCED CONSTRICTIVE PERICARDITIS IN INTESTINAL LYMPHANGIECTASIS. Palmer, H. M.; Cocking, J. B.; Emmanuel, I. G. (Royal Infirmary, Sheffield, Eng.). Brit. Med. J.; 4: 783-4(26 Dec 1970).

A case report was given of a woman of 40 who developed intestinal lymphangiectasis caused by constrictive pericarditis within 5 years of a course of radiotherapy following surgical removal of a scirrhous carcinoma of the left breast. The symptoms of lymphangiectasis with abnormal protein leak receded after pericardiectomy. (UK)

16365 BONE CANCERS INDUCED BY ^{224}Ra (Th X) IN CHILDREN AND ADULTS. Spiess, Heinz (Univ., Munich); Mays, Charles W. Health Phys.; 19: 713-29(Dec 1970).

The average skeletal dose in rads was calculated for 217 juveniles and 708 adults injected with ^{224}Ra (mainly during the years 1946-1951) for the treatment of tuberculosis, ankylosing spondylitis and other diseases. It was determined experimentally that for each 1000 esE stated by the supplier, about 140 μCi ^{224}Ra was injected. For each injected μCi ^{224}Ra, the average dose in rads to the marrow-free skeleton was calculated to be: 0.6 for children aged 1 to 15 yr; 0.4 for adolescents aged 16 to 20 yr; and 0.2 for adults, with each of these values multiplied by the ratio 70 kg/body mass to adjust for body size. The dose from long-lived contaminants appears small compared to that from ^{224}Ra. The total incidence of induced bone sarcomas increased with dose in approximately linear fashion at 1.4% per 100 rads average skeletal dose for the combined juveniles and 0.7% per 100 rads average skeletal dose for the adults. Among the 49 patients developing bone sarcomas as of April 1969, the lowest average skeletal dose was 90 rads, and this patient was an adult. This is much less than the lowest average skeletal dose at death (1200 rads) among the American dial painters who developed bone sarcomas following ingestion of long-lived 1600-yr ^{226}Ra. This difference seems mainly due to the short 3.62 day half-life of ^{224}Ra which causes a large fraction of the skeletal ^{224}Ra to decay while still on bone surfaces. The mean local dose to the cells 0-10 μ from the mineralized bone surfaces is perhaps 9 times the average skeletal dose for ^{224}Ra (assuming half of the skeletal ^{224}Ra decays on bone surfaces and half within the mineral volume), whereas for long-lived ^{226}Ra randomly distributed throughout the mineral volume, the mean local dose 0 to 10 μ from the bone surface is about 0.63 times the average skeletal dose. The effectiveness of ^{224}Ra was similar in males and females, and was similar in patients with and without bone disease at the time of ^{224}Ra injection. Bone sarcomas occurred in 1% of the 402 German spondylitis patients whose skeletal doses from ^{224}Ra averaged 140 rads. This incidence equals the 1% combined incidence of excess leukemia plus excess cancers in the British spondylitis patients whose x ray doses to the spinal marrow averaged about 1000 rads. None of the 21 soft-tissue tumors seems positively related to irradiation (at this time) but correlations may emerge as additional tumors develop. No carcinomas of the head cavities have yet appeared. Two leukemias are recorded, but it is uncertain whether or not these were radiation-induced. (auth) (UK)

16366 AVOIDANCE OF ACUTE SECONDARY DISEASE BY PURIFICATION OF HEMOPOIETIC STEM CELLS WITH DENSITY GRADIENT CENTRIFUGATION. Dicke, K. A.; van Bekkum, D. W. (Radiobiological Inst. TNO, Rijswijk, Netherlands). Exp. Hematol.; No. 20, 126-30(1970).

A modified gradient was developed for the separation of a stem cell concentrate containing a minimum proportion of PHA-responsive cells for human bone marrow punctates. The grafting of stem-cell-rich fractions into irradiated monkeys led to an observation considered important for treatment of radiation accident victims. Experiments were performed on monkeys with 825 to 850 rads of whole-body radiation and grafting of stem cells. It was concluded that purified stem cell concentrates may be employed for treatment of radiation accident victims and prevention of secondary disease. (H.L.W.)

16367 BACKGROUND RADIATION AND DOWN'S SYNDROME. Schuman, Leonard M. (Univ. of Minnesota, Minneapolis); Gullen, Warren H. Ann. N. Y. Acad. Sci.; 171: 441-53(Sep 1970).

An epidemiological study of the relationship of background radiation levels to mongolism rates in 11 towns in Colorado, 24 towns in Michigan, and 18 towns in Minnesota has been presented. The vital birth, infant and fetal death, and hospital records for 54,531 live born and 742 stillborn infants and 1278 infant deaths in these communities were examined for the congenital defect in question. A correlation between background radiation and mongolism was noted for Minnesota only; evidence that this was not a spurious correlation could not be derived, however, primarily because of the nonrandom selection of towns for the study. (auth)

16368 DOWN'S SYNDROME AND EXPOSURE TO X IRRADIATION. Wald, Niel (Univ. of Pittsburgh); Turner, J. Howard; Borges, Wayne. Ann. N. Y. Acad. Sci.; 171: 454-66(Sep 1970).

An attempt was made to evaluate the importance of x irradiation as an agent of the preconceptional environment which increases the frequency of Down's syndrome by affecting the likelihood of nondisjunction or translocation events during gametogenesis. The small numbers of subjects studied with adequate controls, and the conflicting results, do not permit any definitive conclusion concerning the possible role of radiation exposure in the production of Down's syndrome progeny based on evidence of an increased frequency of cytogenetic aberrations in the cultured lymphocytes of Down's syndrome parents. It is clear that in-depth cytogenetic studies of similar, but larger populations with appropriate controls will be required in order to clarify possible relationships. (C.H.)

16369 FEATURES SPECIFIC TO SKIN REACTIONS IN TELEGAMMATHERAPY THROUGH GRID DIAPHRAGMS. Aliev, B. M. (Inst. of Experimental and Clinical Oncology,

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Moscow). Med. Radiol.; 15: No. 9, 57-62(Sep 1970). (In Russian).

Studies of the dynamics of skin reactions in 150 patients with neglected forms of malignant tumors established that in γ-radiotherapy (^{60}Co from one field in static irradiation) the skin reactions in the pattern of grid diaphragm appear both on the side of irradiation and on the contralateral side of the patient's body. In a lesser thickness of the irradiated portion of the patient's body, the skin reactions at the output of the radiation beam appear somewhat earlier than in beam input. The erythemic dose in the beam input averages 16,000 to 20,000 rad, at the output–4,000 to 4,500 rad. On increasing the exposure dose to 20,000 to 25,000 rad in open areas of the field, a marked erythema appears, whereas in doses of 25,000 to 30,000 rad, exudative epidermitis appears. (auth)

16370 LIST OF AUTOPSY MATERIALS IN CUSTODY AT THE A-BOMB MEDICAL RECORDS AND SPECIMENS CENTER. Fukazawa, Kaichi; Sumida, Masafumi; Yanagida, Izumi (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 11, 195-201(1970). (In Japanese).

Autopsy specimens were transferred from ABCC-JNIH Hiroshima Branch Laboratory and Hiroshima Prefectural Hospital to the A-bomb Medical Records and Specimens Center in 1970. These materials are all kept in good condition. Autopsy specimens of 4,552 cases kept in the A-bomb Medical Records and Specimens Center are listed in the Proceedings of the Research Institute for Nuclear Medicine and Biology. (auth)

16371 STUDIES ON THYROID CANCER INDUCED BY A-BOMB EXPOSURE. Ezaki, Haruo; Shigemitsu, Takao (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 11, 166-8 (1970).

A statistical study of the development of thyroid cancer among survivors of the atomic bomb was made and the clinical and pathological differences between thyroid cancer in exposed and unexposed persons were studied. It was found that the incidence was high among the exposed. The incidence was found to be highest among those exposed between 15 and 30 years of age. There was no difference in the histological pattern of the tumors, in the extent of carcinomatous invasion at the time of surgery, or in the results of surgical treatment among patients derived from the exposed and unexposed populations. (H.L.W.)

16372 NEOPLASMS AFTER CHILDHOOD IRRADIATION OF THE THYMUS GLAND. Janower, Murray L. (Massachusetts General Hospital, Boston); Miettinen, Olli S. J. Amer. Med. Ass.; 215: 753-6(1 Feb 1971).

The oncogenic effects of childhood irradiation of the thymus gland were investigated by following up 466 irradiated subjects, 506 unirradiated subjects with similar illnesses, and the siblings of both series. In the irradiated group there were two malignant and nine benign thyroid neoplasms, indicating an excess risk in this group. There was also a suggestion of an increased risk of breast cancer. There was no evidence of difference between the hospital and sibling controls; this supports the validity of previous studies using sibling controls. (auth)

16373 SCRATCH ONE MORE RADIATION MYTH. Barber, Donald E. (Univ. of Minnesota, Minneapolis). Power Eng.; 75: No. 1, 33-5(Jan 1971).

Some of the claims regarding a causal relation between leukemia and low doses of radiation are examined. Three situations in which this relation was suggested or implied are discussed and inconsistencies regarding either the handling of the data or the subsequent conclusions drawn from the data are presented. The data under consideration include: radioactivity in the Columbia River and the observed high mortality from cancer among residents near the south bank; nationwide leukemia mortality and radioactive fallout; and Minnesota leukemia mortality and radioactive fallout. Evidence supporting relations between leukemia mortality and a variety of other factors, rather than radioactivity, is presented. (E.R.B.)

Radiation Effects on Plants

Refer also to abstracts 16089, 16091, 16099, 16106, 16108, 16110, 16279, and 16307.

16374 (COO-2085-1) EFFECTS OF IRRADIATION ON LICHENS AND LICHEN-FORMING FUNGI AND ALGAE. Technical Progress Report. (Michigan Technological Univ., Houghton. Dept. of Biological Sciences). Dec 1970. Contract AT(11-1)-2085. 14p. Dep. NTIS.

Studies on respiration of lichens, Cladonia cristatella, and bacteria occurring on them showed that the rate of respiration in bacteria was less than one-tenth that of the lichens. Lichens given 2000 kR of γ radiation continued to respire at the same rate as unirradiated lichens. It was concluded that respiration could not be used as an index of radiation damage. It was found that lichens treated with 10 to 1000 kR of γ radiation contained damaged algal cells; therefore the number of damaged cells was used as an index of radiation damage to the lichen. Another index of radiation damage was the appearance of the lichen on infrared film. Chromatographic studies were made of the effects of radiation on pigments of lichens. Following chronic irradiation over several months and large doses of acute radiation, a reduction in pigment concentration was found. Experiments were conducted on the uptake of ^{32}P by irradiated and unirradiated lichens. The ^{32}P uptake was considerably reduced in the irradiated lichens. Sections of podetia were made and covered with radiosensitive stripping film to determine localization of ^{32}P in the tissues. Microscopic studies of irradiated and non-irradiated lichens were made to determine cell damage and developmental patterns. Cytological studies were made on lichens collected from irradiated forest sites; results are being correlated with distribution and climatic changes. (H.L.W.)

16375 (JPRS-52121, pp 58-62) RELATIVE BIOLOGICAL EFFECTIVENESS OF MULTICHARGED IONS DURING SINGLE IRRADIATION OF CHLORELLA. Vekshina, L. K.; Kogan, I. G.; Kudryashov, E. I.; Marennyi, A. M.; Pyatyshev, D. R.; Sakovich, I. S.; Shevchenko, V. A. Translated from Kosm. Biol. Med.; 4: No. 5, 39-42(1970).

The dose dependence of relative biological effectiveness of accelerated C-12 ions was determined. An increase in the inactivation cross section with an increase in linear energy transfer of ionizing radiation was demonstrated. A dose-dependent change in Chlorella mutability was observed. (auth)

16376 (ORO-678, pp 135-51) CONTROL AND MODIFICATION OF SEED RADIOSENSITIVITY. Conger, B. V.; Constantin, M. J. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Annual progress report, January 1–December 31, 1969.

Studies on modification of damage induced in barley seeds by unmoderated fission neutrons included influence of seed water content on oxygen-independent damage; oxygen-effect in very dry seeds; influence of seed water content on oxygen dependent damage; comparison of barley seedling growth response following seed irradiation at ASTRA and HPRR; and effects of packaging material and postirradiation storage on seeds of 13% water. Experiments on effects of 14.7 MeV neutrons in combination with various modifying factors on seeds included influence of oxygen on very dry seeds of Himalaya barley; influence of seed water content on oxygen-independent damage in seeds of Himalaya barley and Bluebonnet rice; and influence of postirradiation storage on oxygen-independent damage in Himalaya barley seeds. Experiments were initiated on effects of oxygen on sensitivity of seeds of barley, rice, cucumber, onion, and radish to ionizing radiation. (H.L.W.)

16377 RADIATION SENSITIVITIES OF WHEAT GRAIN SPOILAGE FUNGI. Mohyuddin, Mirza; Skoropad, William P. (Univ. of Alberta, Edmonton). Nucleus (Karachi); 6: 151-4 (Jul-Sep 1969).

Gamma radiation sensitivities of grain spoilage Penicilli and Aspergilli were determined, in the form of survival curves. The radiation was applied at five dose levels of 25, 50, 75, 100 and 125 krad. Various species differed significantly in their resistance towards gamma irradiation and the survival curves were sigmoidal in nature. (auth)

16378 RESTORATION EFFECT OF YEAST EXTRACTS ON THE VEGETATIVE DEVELOPMENT OF RICE SEEDS (ORYZA SATIVA L., VAR. CIGALON) IRRADIATED BY ^{60}Co GAMMA RAYS. Laignelet, Bernard; Fouletier, Bernadette; Jonard, Robert (Ecole Nationale Superieure Agronomique, Montpellier, France. Montpellier Univ., France). Compt. Rend., Ser. D; 271: 1884-7(23 Nov 1970). (In French).

Yeast extracts used at concentrations of 1.5 ‰ produce a restoration effect with rice plantlets grown from irradiated seeds (30, 35 and 40 kR). The effect on the vegetative system is analyzed. (France)

16379 ISOLATING ENTOMOGENOUS FUNGI AND BACTERIA, AND TESTS OF FUNGAL ISOLATES AGAINST THE SOUTHERN PINE BEETLE. Moore, Gordon E. (Forestry Sciences Lab., Research Triangle Park, N. C.). J. Econ. Entomol.; 63: 1702-4(Oct 1970).

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A method for eliminating saprophytic fungal overgrowth on southern pine beetles, Dendroctonus frontalis Zimmerman, in order to detect internal and nonsporulating organisms was described. Ultraviolet radiation was used to eliminate surface contaminants. However, species of fungi found inside the beetles were the same as those on the outside in 11 out of 16 genera. Some bacterial and fungal pathogens occurred in the same beetle. (E.E.H.)

16380 USE OF γ RADIATION TO OBTAIN BASIC MATERIAL FOR SELECTIONS OF SUNFLOWERS. Zezyulinskii, V. M.; Grechanovskaya, T. M.; Gol'dshmid, L. G. Selek. Semenovod.; No. 6, 41-3(1969). (In Russian).

Comparative studies were made of the effects of seed exposure, chronic, and single phase γ irradiation on the growth of sunflowers. Gamma irradiation of air-dried seeds with up to 100,000 R inhibited growth of the sprouts. Chronic exposure of the plant with 0.15 up to 25 R/hr or total doses of 300 to 5,000 R increased the seed harvest and quality of the plant. Irradiation with 5 R/hr strongly inhibited growth. Experiments during 1966 to 1968 showed that chronic or single irradiation of plants during various growth stages improved plant development and seed harvest. (R.V.J.)

16381 INFLUENCE OF IONIZING RADIATION ON THE PROTEIN CONTENT IN THE GRAIN OF SPRING CROP WHEAT. Chistova, K. N. Selek. Semenovod.; No. 4, 77(1969). (In Russian).

Studies of γ radiation effects on the protein content in various types of spring crop wheat grains showed that the radiation effects varied with the types of grain. Larger harvest yields were obtained only with Saratov-29 and Narodnaya varieties γ-irradiated with 2700 R. With increased dose, the harvest yield diminished, especially the yield of Lutescence 62 type grain. (R.V.J.)

16382 DISTURBANCES IN THE DEVELOPMENT OF HEMP POLLEN INDUCED BY PRESOWING GAMMA IRRADIATION OF SEEDS. Migal, N. D.; Kovalenko, V. M. Tsitol. Genet.; 4: 342-6(1970). (In Russian).

It is established that γ irradiation of hemp seeds causes a partial male sterility of plants M_1. The disturbances in pollen development take place after the division of the mother pollen cell. The type of male sterility is manifested by formation of empty (without plasma) pollen grains that lose their ability to germinate. With an increase of irradiation dose the degree of male sterility rises. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 16042, 16043, 16054, 16095, 16104, 16107, 16109, 16234, 16277, and 16283.

16383 (UCB-34-P-156-X-2) COMPREHENSIVE PROGRESS REPORT [ON GENETICS, THREE YEARS, FEBRUARY 1968-FEBRUARY 1971]. (California Univ., Berkeley. Dept. of Biochemistry). Contract AT(04-3)-34. 6p. Dep. NTIS.

Experiments were conducted on development of bacterial strains specific for detecting various types of mutagens. Studies on identification of mutagens causing specific alterations in DNA were continued. Over a thousand mutants were isolated primarily in the histidine operon after mutagenesis by a variety of mutagens. A theory explaining the evolution of bacterial base ratios as a consequence of the species exposure to ultraviolet radiation in sunlight was developed. A correlation was shown between low adenine plus thymine content in bacterial DNA and the amount of sunlight to which the bacterium is normally exposed. Studies were continued on selection of dominant mutations by direct plating of mutagenized cultures. Carbon and nitrogen sources for growth of Salmonella typhimurium were determined for studies on the function of the 4000 genes. Studies were continued on isolation of temperature-sensitive and other mutants in specific regions of the chromosome. Continuation plans are described for improving tester strains and developing new strains to maximize sensitivity and specificity of response to class of mutagen. (H.L.W.)

16384 EFFECT OF OXYGEN ON FREEZING DAMAGE. I. EFFECT ON SURVIVAL OF ESCHERICHIA COLI B/r AND ESCHERICHIA COLI B_{s-1}. Swartz, Harold M. (Walter Reed Army Medical Center, Washington, D. C. Georgetown Univ., Washington, D. C.). Cryobiology; 6: 546-51(May-Jun 1970).

The presence of oxygen in the freezing medium was found to affect freezing damage. A reduced survival and an increased radiation sensitivity were found in Escherichia coli B_{s-1} frozen from oxygen-saturated solutions. E. coli B/r did not show these effects. These results are consistent with a theory that oxygen effects are mediated by free radical reactions. It is suggested that the oxygen content of freezing media may be a significant variable in cryobiology. (auth)

16385 POST-IRRADIATION DNA DEGRADATION AND RESPONSE TO FRACTIONATED DOSES IN MICROCOCCUS RADIODURANS. Fox, Margaret; Hopkins, Josephine (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol.; 18: 507-19(1970).

The response of Micrococcus radiodurans to fractionated doses of 10 MeV electrons (5 μsec pulses at $\approx$100 rads/pulse and 50 pulses/sec) given during the post-irradiation division delay was studied. When incubated at 30°C under growth conditions, bacteria were most resistant when the second dose was given 1 or 2 hrs after the first, and most sensitive between 3 and 4 hrs. At 4°C smaller changes in sensitivity were observed. Incubation in PO_4 buffer at 30°C resulted in greater sensitivity to divided doses than to the single dose at all times studied, i.e. no recovery. Loss of activity from ^{125}IUdR-labeled cells incubated in broth after irradiation was much less at 4°C than at 30°C. Post-irradiation incubation of pre-labeled cells in PO_4 buffer at 30°C resulted in significant but not progressive loss of activity. DNA degradation and fractionation response may be associated for cells held in broth, but when cells were held in buffer DNA degradation occurred in the absence of recovery. Two-dose response curves at 1, 2 and 3.5 hrs demonstrated that the fractionation pattern obtained depends on the size of the second dose. (auth) (UK)

16386 TRAPPING OF UNREPLICATED PHAGE DNA INTO SPORES OF BACILLUS SUBTILIS AND ITS STABILIZATION AGAINST DAMAGE BY ^{32}P DECAY. Sonenshein, Abraham L. (Massachusetts Inst. of Tech., Cambridge). Virology; 42: 488-95 (Oct 1970).

The genome of phage ϕe enters the developing spore without prior replication. Nonetheless, ^{32}P-labeled phages become stabilized to decay when incorporated into spores. This latter phenomenon is accompanied by resurrection on passage through the spore of phages previously damaged by ^{32}P decay or electron irradiation, suggesting the existence of an efficient repair process during germination. (auth)

16387 IRRADIATION OF PHAGES WITH FAST PROTONS. Candoni, B.; Corno, C. (Univ., Milan). pp 204-8 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

Dry preparations of bacteriophages both with single-strand and with double-strand nucleic acid were irradiated with fast protons from the Milan AVF Cyclotron. The inactivation cross-section was determined by measuring the plaque-forming ability of the phages. For single-strand DNA and RNA phages, experimental data seem to confirm the lethal effect of all hits on the nucleic acid; for double-strand phages it was observed that the sensitive volume was much smaller than the DNA volume. Some possible processes of inactivation are discussed. (auth) (UK)

16388 SENSITIZED PHOTOINACTIVATION OF BACTERIOPHAGE T4. Meistrich, M. L. (Bell Telephone Labs., Murray Hill, N. J.); Lamola, A. A.; Gabbay, E. Photochem. Photobiol.; 11: 169-78(1970).

The photoinactivation of an osmotic shock resistant mutant of the bacteriophage T4 can be sensitized by two cationic derivatives of acetophenone. At least part of the sensitized inactivation appears to be caused by the formation of thymine dimers in phage DNA by a mechanism which involves triplet excitation transfer from the sensitizer to thymine in the DNA. The photoreactivable sector of the phage inactivated by sensitized irradiation is about 0.6, almost twice as large as the sector for uv irradiated phage. (auth) (UK)

Radiosterilization and Radiopreservation

Refer also to abstracts 16089 and 16294.

16389 (AED-C-5-8) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 05. RADIATION EFFECTS ON FOOD. Beising, Kurt (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Aug 1970. 84p. Dep. NTIS (U. S. Sales Only).

A list is presented of approximately 450 recent publications

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that discuss the use of ionizing radiations in food processing. Abstracts of most of the references appeared in NSA Vol. 20 and Vol 21. (C.H.)

16390 (JPRS–52121, pp 63-8) EFFECT OF IONIZING RADIATION ON FOOD PRODUCTS. Bychkov, V. P.; Kozar, M. I.; Popov, V. I.; Boyko, N. N.; Kasatkina, A. G.; Kolchin, E. V.; Yurgov, V. V. Translated from Kosm. Biol. Med.; 4: No. 5, 42-6(1970).

Experimental data describing the effect of γ irradiation in doses of 35,000 and 70,000 Rad on the physicochemical and organoleptic properties of casein, sunflower seed oil, yeast, and oil concentrates of vitamins A and D were presented. It was found that a single irradiation of these products reduces some essential amino acids, destroys significant quantities of water-soluble and small quantities of fat-soluble vitamins in foods, and increases the concentration of peroxides in sunflower seed oil. (auth)

16391 (MIT–4049–2) TOXIN PRODUCTION BY NATURALLY OCCURRING LEVELS OF CLOSTRIDIUM BOTULINUM IN IRRADIATED AND NONIRRADIATED SEAFOOD. Final Report, 1970 (Revision). Nickerson, J. T. R.; Goldblith, S. A. (Massachusetts Inst. of Tech., Cambridge). Jan 1971. Contract AT(30-1)-4049. 26p. Dep. NTIS.

A total of 150 samples (450 individual portions) of commercially produced cod and haddock fillets have been incubated and tested for botulinum toxin. Each sample consisted of ground and mixed cod or haddock fillets, packaged in polyethylene as three different 100 gram portions. Among the three 100 gram portions which made up each sample, one received no further treatment, one was irradiated with gamma rays at a dose level of 100 krad and one was irradiated with gamma rays at a dose level of 200 krad. (As packaged the conditions in the fish portions were aerobic but doubtlessly changed to anaerobic as bacterial growth proceeded during incubation.) All portions of all samples were incubated for 6 days at 70°F, then extracted with cold gel-phosphate buffer. Portions of the trypsinized and nontrypsinized extracts were injected intraperitoneally into mice (protected and nonprotected with botulinum antitoxin, types A, B and E) and the mice were observed over a period of 96 hours for symptoms of botulism and death. All mice had been treated with antibiotics prior to injection. Among the 450 individual portions tested, only one, a 200 krad treated portion, caused symptoms and death typical of botulism upon injection into mice. Because of various circumstances (time of death in animals protected with individual antitoxins, A, B and E, and the symptoms exhibited by injected mice), it was concluded that this portion contained type A botulinum toxin. None of the portions treated with gamma rays at a level of 100 krad and none of the untreated samples produced symptoms of botulism in mice when extracts were injected. The dose rate of the Mark II cobalt^{60} source was determined. This was done in such a manner that the same mass was present in the irradiation chamber as when fish fillets were irradiated in quantities of 20 pounds (two 10 pound containers) and as the 100 gram portions were irradiated for the experiments reported herein. (auth) (TSS)

16392 STUDY OF RADIATION-STERILIZED DRUGS AND THEIR AQUEOUS SOLUTIONS. Pandula, E.; Farkas, E.; Nagykaldi, A. (Medizinische Fakultaet, Budapest). Pharmazie; 25: 254-8(Apr 1970). (In German).

Little or no degradation occurred when the following substances were γ-irradiated: ephedrine hydrochloride, lidocaine hydrochloride, codeine hydrogen tartrate, morphine hydrochloride, chloramphicol, glucose, ascorbic acid, and vitamin B_{12}. However, when the drugs were irradiated in dilute solutions intensive changes occurred. The decomposition could be followed using the uv spectra and the polarograph. When solutions with a drug content of more than 2% are irradiated, the degradation amounts to only 1 to 2%. (tr-auth)

16393 RADIATION PROCESSING OF POULTRY WASTES. Jackson, W. M. (American Nuclear Corp., Oak Ridge, Tenn.). Isotop. Radiat. Technol.; 8: 223-5(1970-71).

An irradiator for sewage and animal wastes that is almost 100% efficient in utilization of the γ energy from ^{60}Co or ^{137}Cs is described. The flow-through design uses several passes by the centrally located sources to ensure uniform dosage to the liquid, with the total dose to the liquid being determined by the activity of the sources and the flow rate through the irradiator. A unique feature of the design is the provision for removal of the solids from the inner walls of the irradiator, which could decrease the radiation dose to the liquid and impede flow. Applications of this instrument for processing poultry wastes are discussed. (H.L.W.)

16394 POTATO-SPROUT INHIBITION BY RADIATION. PART I. McKinney, F. E. Isotop. Radiat. Technol.; 8: 187-210(1970-71).

The use of radiation to inhibit sprouting of potatoes is reviewed. Early research in the field and the legislation it led to are covered. The results of 16 years' research in 23 countries, including the United States, are presented. Also included is a comparison with chemical sprout inhibitors and the currently accepted explanation of how radiation accomplishes this beneficial task. (auth)

16395 PROPOSED METHOD FOR TESTING THE POSSIBILITY OF A BOTULISM HAZARD IN RADIATION-PASTEURIZED FISH. Ronsivalli, L. J. (Bureau of Commercial Fisheries, Gloucester, Mass.); Schwartz, M. S.; Nickerson, J. T. R. Isotop. Radiat. Technol.; 8: 211-18(1970-71).

The promise of economic savings from the use of ionizing radiation to preserve fish is weakened by the uncertainty as to whether or not this treatment allows botulinum Type E toxin to develop before the consumer rejects the product because of obvious spoilage. The test proposed here compares the specific time at which the consumer can detect spoilage in either irradiated or nonirradiated fish with the specific time at which toxin develops in the products. The available data indicate that this test can determine whether or not a botulism hazard exists. (auth)

16396 STERILIZATION BY RADIATIONS. Thalheimer, M. Rev. Hyg. Med. Soc.; 18: 317-20(Mar-Apr 1970). (In French).

Three methods were used for radiation sterilization: accelerated particles, ^{60}Co γ rays and ^{137}Cs γ rays. All three instruments exist in France, but these sterilization methods were more highly developed abroad. In general, sterilization was carried out at 3 megarads, tetanus spores being destroyed at 1.5 megarads. It should be noted that insufficiently treated microbes offer a certain resistance. The sensitivity to sterilization appeared to be higher at 50° and lower in the presence of moisture and after freezing. The materials sterilized were mainly polyethylene, silk, cotton, and organic products. This method was incomparable for the sterilization of plastic syringes, needles, transfusion tubes, catheters, the small implements used to remove stitches, and vaccination lancets. The sterilization of surgical overalls, masks, and gloves is being studied at present. The process can only be fully guaranteed on condition that the material sterilized is clean. (auth) (France)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 18174.

16397 (AGARD-CP-73-71) HIGH TEMPERATURE TURBINES. Papers Presented at the 36th Meeting of the AGARD Propulsion and Energetics Panel held, Florence, Italy, September 21–25, 1970. (Advisory Group for Aerospace Research and Development, Paris (France)). Jan 1971. 610p. (In French and English). (CONF-700946).

Thirty-two papers were presented at the meeting. A separate abstract was prepared for each of five papers. Papers for which no abstracts were prepared are concerned with turbogenerators, heat transfer, cooling methods, and mechanical problems. (J.R.D.)

For abstracts of individual papers see: 16402, 16403, 16419, 16420, and 16437.

16398 (IS–2300, pp 101–86) METALLURGY DIVISION. Bailey, D. M.; Carlson, O. N.; Chen, C. W. (and others) (Ames Lab., Iowa).

From Ceramic Engineering, Chemical Engineering, Chemistry, Mathematics and Computer Science, Metallurgy, Physics, and Reactor Divisions annual summary research report, July 1969–June 1970.

Research progress is reported in investigation programs on preparation and purification of cladding metals, properties of reactor materials, separation processes for liquid metals and fused salts, metal deformation, physicochemical properties of metals, diffusion and transport, properties of surfaces, radiation effects on materials, and characterization of materials. (J.R.D.)

16399 (ORNL–4622, pp 119–98) MATERIALS DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

From Molten-Salt Reactor Program.

Progress is reported for the materials development program for the MSRE that includes examination of the MSRE components, graphite and Hastelloy N studies, and support for chemical processing. (D.H.M.)

16400 APPLICATIONS OF RADIOISOTOPES IN METALLURGY. Dara, S. S.; Misra, V. N. (Visvesvaraya Regional Coll. of Engineering, Nagpur, India). J. Sci. Ind. Res.; 29: 403–13(Sep 1970).

The applications of radioisotopes in the study of fundamental metallurgical problems are reviewed. The basic principles involved in the use of radioisotopes in metallurgy are discussed and the methods of incorporating activity into the metallurgical specimens are described. Typical examples of the use of radioisotopes in diffusion studies, flaw detection, blast furnace practice, steel making, and in other important physical and extractive metallurgical problems are presented. (auth)

Corrosion and Erosion

Refer also to abstracts 15809, 15838, and 15847.

16401 (AD–711634) OXIDE FORMATION IN EVAPORATED THIN FILMS OF TANTALUM. Lawless, Kenneth R.; Berting, Frances M. (Virginia Univ., Charlottesville. Research Labs. for the Engineering Sciences). Aug 1970. Contract N00014-69-A-0060-0002. 210p. (MS–3531-110-70-U). NTIS.

The oxidation of evaporated single crystal Ta films was carried out in situ in the electron microscope. In order to provide greater assurance that the gas reacting with the Ta film was oxygen rather than nitrogen or carbon vapors residual in the electron microscope column, a vacuum system was designed and assembled to provide auxiliary pumping directly on the sample chamber; a liquid nitrogen cooled plate was installed in the chamber above the sample to trap contamination; and an oxygen inlet was inserted at the level of the sample itself. Tantalum films of (001) orientation were prepared by evaporation in a separate high vacuum station, using a 2 kW electron beam gun. Two progressions of oxidation were observed, one under the low oxygen pressure conditions and one under the higher oxygen pressure. The ordered domains producing the 2-fold cubic superlattice are thought to be an early stage of TaO (y), the orthorhombic platelets a later form with the same suboxide designation. (auth) (USGRDR)

16402 (AGARD-CP-73-71, Paper 20) PROTECTION BY THERMO-CHEMICAL MEANS OF REFRACTORY SUPERALLOYS FOR AIRCRAFT GAS TURBINES. Galmiche, Philippe (Office National d'Etudes et de Recherches Aerospatiales, Chatillon-Sous-Bagneux (France)). 12p. (In French).

From High temperature turbines.

. A survey of the corrosion problems of refractory materials for gas turbines, as they appear at present in the case of the most advanced superalloys is presented. The main protection methods of refractory superalloys now in use or under study are reviewed and the chromaluminization method that has been developed at O.N.E.R.A. is described. A particular attention is paid to analyzing particular problems as well as novel applications of the O.N.E.R.A. techniques. (auth)

16403 (AGARD-CP-73-71, Paper 22) COMPOSITION, MICROSTRUCTURE, AND PROTECTION AFFORDED BY SEVERAL COMMERCIAL COATINGS ON TWO NICKEL-BASE ALLOYS. Stetson, A. R.; Moore, V. S. (International Harvester Co., San Diego, Calif. Solar Div.). 56p.

From High temperature turbines.

Six commercially available aluminide coatings, three on IN-100 alloy and three on B1900 alloy, were evaluated by simulated turbine environmental testing (rig testing). The environment was the combustion products of JP-5 fuel and air at 0.85 Mach. No appreciable salt content (<0.014 ppM NaCl) was ingested during the test to influence the results. Coating performance was assessed by weight change and metallographic methods. Electron microprobe x-ray analyses and, to a limited extent, x-ray diffraction were carried out to identify phases and define compositional differences which could be related to performance. Types of aluminide coatings included in this evaluation program were those containing significant quantities of (1) silicon; (2) chromium applied either before or after the aluminum; and (3) ceramic material. Coatings were also represented that were hyper- and hypo-stoichiometric in the β NiAl system. Interdiffusion of aluminum and nickel at the coating-substrate interface was a significant factor in coating degradation in the maximum test temperature range of 1037 to 1172°C. The coating with chromium at the β NiAl-substrate interface provided the least loss of aluminum by inward diffusion and least outward diffusion of nickel; however at temperatures near 1150°C, the chromium destabilized the γ' phase and resulted in a wide band of γ in equilibrium with β NiAl. The Cr also promoted σ phase formation at the lower temperatures. Other additives showed minor compositional influences on the structure and performance of the coatings. In general, the coatings with the greatest initial aluminum reservoir (thickness) provided the greatest protection. Hyper- rather than hypo-stoichiometric coatings appeared to provide longer protection at the maximum test temperature. The substrate also influenced coating performance with the coatings on B1900 showing consistently better performance than coatings on IN-100. (auth)

16404 (ANL–7663) LITHIUM/SELENIUM SECONDARY CELLS FOR COMPONENTS IN ELECTRIC VEHICULAR-PROPULSION GENERATING SYSTEMS. First Semiannual Technical Summary Report, May 23–November 22, 1969. Cairns, E. J.; Gay, E. C.; Kolba, V. M.; Kyle, M. L.; Tevebaugh, A. D.; Trevorrow, L. E. (Argonne National Lab., Ill.). Apr 1970. Contract W-31-109-eng-38. 22p. Dep. NTIS.

Eight lithium/selenium cells with 7.5-cm-dia paste electrolyte (44.2-cm^2 total area, 31.6-cm^2 active area) have been designed, fabricated, and tested. Short-time peak-power densities up to 2 W/cm^2 were delivered by these cells, and up to 60% of the theoretical capacity density was achieved (at 0.15 A/cm^2). Cell lives of 50 hr (10 cycles) have been demonstrated. Lack of wetting of paste electrolyte by lithium in some cells has resulted in high internal resistance and correspondingly poor electrical performance. Vapor deposition of lithium on the paste before assembly of the cell may alleviate this wetting problem. Initial measurement results on paste-electrolytes indicate that resistivity ratios as low as 3 may be achievable. Materials stability and corrosion tests have shown that a few high-temperature polymers are stable at 375°C, but are not resistant to lithium at that temperature. Several ceramic materials, which could serve either as fillers or electronic insulators, are resistant to lithium at 375°C. The metals most resistant to lithium–selenium mixtures at this temperature are beryllium, niobium, Nb-1% Zr, and chromium. (auth)

16405 (ANL–7756) DEVELOPMENT OF HIGH-ENERGY BATTERIES FOR ELECTRIC VEHICLES. Progress Report for February 1969–June 1970. Cairns, E. J.; Kyle, M. L.; Maroni, V. A.; Shimotake, H.; Steunenberg, R. K.; Tevebaugh, A. D. (Argonne National Lab., Ill.). Jul 1970. Contract W-31-109-eng-38. 54p. Dep. NTIS.

The applicability of lithium/chalcogen cells to secondary batteries for vehicular propulsion is being investigated. During this period, cathode materials containing sulfur, P_4S_{10}, and P_4S_3 were tested in cells operated at 325 to 400°C. Liquid-electrolyte lithium/sulfur cells have exhibited capacity densities from 0.1–

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0.2 A-hr/cm^2 at a current density of 0.5 A/cm^2. Sulfur utilization has usually been less than 35%. Cathode current-collector structure was found to have a significant effect on cell performance. Improved capacity density, near 0.5 A-hr/cm^2 at a current density of 0.5 A/cm^2, was achieved by means of a laminated cathode structure. Potential construction materials for lithium/sulfur cells were subjected to 600-hr corrosion tests at 375°C. Molybdenum, chromium, and niobium showed corrosion rates sufficiently low for use in cells of anticipated lifetimes greater than 1000 hr. (auth)

16406 A STUDY ON THE INTERNAL OXIDATION OF Ag–Cd ALLOYS. Kabayama, Sukeaki; Kamijo, Eiji. Sumitomo Elec. Tech. Rev.; No. 14, 110-15 (Nov 1970).

A solid solution of silver containing 5 to 20 wt % cadmium was internally oxidized at temperatures between 600 and 800°C under various oxygen partial pressures. The depth of the subscale formed and the microstructure were observed by microscope, and the distribution of alloy elements was determined with electron probe micro-analyzer. The depth of the subscale formed was proportional to the fourth root of the surface oxygen partial pressure. The activation energy for diffusion of oxygen through the internally oxidized layer was calculated by Wagner's equation, yielding about 20 kcal/mole. The size of precipitated CdO particles was considered by the nucleation and growth model, and explained by the feed velocity ratio of the oxygen to solute cadmium at the oxidation front. The cadmium depleted zone was observed in the center of the fully oxidized strip, especially when the diffusion rate of oxygen was small as compared with the diffusion rate of solute cadmium. The width of the depleted zone was proportional to the thickness of the specimen, the concentration of the solute cadmium and the second root of the diffusion ratio of the solute cadmium to oxygen, while it was in inverse proportion to the fourth root of oxygen partial pressure. (auth)

16407 KORROZIYA I ZASHCHITA METALLOV. SBORNIK STATEI. (Corrosion and Metal Protection. Collection of Papers). Rozenfel'd, I. L. (ed.). Moscow; Izdatel'stvo Nauka (1970). 216p.

Corrosion resistance of various alloys is discussed and new methods used for increasing the passivity of metals are described. A brief review is given of volatile atmospheric corrosion inhibitors, methods for protection of metallic surfaces by means of surface-active agents and polymer coatings. (R.V.J.)

16408 DEHYDROGENATION OF ZIRCONIUM OR ZIRCONIUM ALLOY BODIES. Visani, Tino (to EURATOM). British Patent 1,217,504. 31 Dec 1970. Filed 7 Nov 1967.

Reference is made to methods for the dehydrogenation of Zr or Zr alloy structures, the surfaces of which are partly in contact with a hydrogenating medium such as high temperature water or steam, for example pressure tubes of fuel element cladding in nuclear reactors. In the method described the part of the structure not in contact with the corroding medium is covered wholly or in part with a metal that catalyzes the reaction of hydrogen with an oxidizing medium such as O_2 or CO, and this part is enveloped in an atmosphere containing oxygen. The catalyst metal may comprise a Group VIII metal, such as Rh, Ir, Pd, Pt, Ni or Fe, or metals such as Cu, Ag, Cr or Co or alloys or mixtures thereof. Such metals promote reaction of the hydrogen, even if it is in the form of solid solution in the Zr, with O_2 or CO at the surface so that the hydrogen is extracted from the whole of the metal. The catalyst metal can be applied to the surface of the Zr as a continuous or non-continuous thin layer or coating, or it can be applied by welding wires or pieces of the metal. In the case of a reactor pressure tube with one side in contact with steam, the opposite side can be covered with a thin layer of catalyst metal and an atmosphere containing the oxidising gas maintained on the latter side. Experimental tests are described. (UK)

16409 FRICTION AND WEAR OF BALL BEARINGS IN LIQUID SODIUM. Uga, Takeo (Japan Atomic Energy Research Inst., Tokai); Ikushima, Takeshi; Nozawa, Masao; Sugiyama, Hiroaki. J. Nucl. Sci. Technol. (Tokyo); 8: 16-22(Jan 1971).

An experimental study on the friction and wear properties of ball bearings has been conducted in liquid sodium at 400°C. Out of a number of materials compatible with sodium, Stellite 6, Hastelloy C, and austenitic stainless steel (AISI 316) were chosen. A medium size, single-row, deep groove, radial-type ball bearing was selected for the form of test bearings. It was found that of the three materials, the hardest material (Stellite 6) showed the highest resistance against wear, and the greatest recovery effect from friction. Liquid sodium appears to contribute little as lubricant, due to its low viscosity and extremely high chemical activity. No tendency toward self-welding was, however, observed at temperatures up to 400°C, despite the mean compression stress applied having been over three times the yield strength. The wear of ball bearings in liquid sodium is considered to be caused by local sliding friction. The wear rate is higher the softer the material in contact. (auth)

16410 VAPORIZATION CHEMISTRY IN THE OXIDATION OF CARBON, SILICON, CHROMIUM, MOLYBDENUM, AND NIOBIUM. Gulbransen, Earl A.; Jansson, Sven A. (Westinghouse Research Labs., Pittsburgh). pp 181-208 of Heterogeneous Kinetics at Elevated Temperatures. /Belton, G. R. (ed.). New York; Plenum Press (1970).

From International Conference on Heterogeneous Kinetics at Elevated Temperatures, Philadelphia, Pa. See CONF-690927.

Six types of oxidation processes occur in the oxidation of materials at high temperature. Reactions involving volatile species are important in evaluating and understanding the use of materials at high temperature. Thermochemical diagrams were used to analyze the complex equilibria found in the oxidation of carbon, silicon, chromium, molybdenum, and niobium. The results were compared with experimental oxidation data. (auth)

16411 KINETICS OF THE ATTACK OF REFRACTORY SOLIDS BY ATOMIC AND MOLECULAR FLUORINE. Rosner, Daniel E.; Allendorf, H. Donald (Yale Univ., New Haven. AeroChem Research Labs. Inc., Princeton, N. J.). J. Phys. Chem.; 75: 308-17(4 Feb 1971).

The true high-temperature kinetics of the attack of molybdenum and tungsten surfaces by atomic fluorine were studied using microwave discharge-fast flow vacuum system techniques coupled with electrical resistance heating of the reacting specimens. Experimental results are reported covering the surface temperature range from 700°K to the sublimation thresholds of these metals, at estimated F atom pressures from 6×10^{-4} to 8×10^{-2} torr. Corresponding experiments were carried out using diatomic fluorine at comparable fluorine gas pressures, and covering the same filament temperature range. For reasons having to do with the estimation of absolute F-atom concentrations, exploratory kinetic data are also included for the fluorination of titanium, graphite, and boron. It is shown that despite the well-known reactivity of molecular fluorine, prior dissociation produces a marked enhancement in the Mo- or W-atom removal probability at fluorine fluxes and surface temperatures corresponding to appreciable steady-state adatom populations. Interestingly enough, multiple local maxima appear in the Arrhenius diagram for the F-atom attack of Mo(s) and X(s); these maxima are attributed to the formation–desorption of distinct metal fluorides of widely disparate stoichiometry and thermodynamic stability. When the observed high-temperature phenomenon of metal sublimation is included, some metal atom removal rates can be achieved at five distinct surface temperatures. Mechanistic implications of these new results are discussed, together with suggested extensions of this work. (auth)

16412 PROCEEDINGS OF THE FIRST JOINT AEROSPACE AND MARINE CORROSION TECHNOLOGY SEMINAR, LOS ANGELES, CALIFORNIA, JULY 10–12, 1968. Houston, Tex.; National Association of Corrosion Engineers (1969). 129p. (CONF-680732).

Twenty papers were presented at the conference. A separate abstract was prepared for each of six papers. Papers for which no abstracts were prepared are concerned with corrosion in aerospace propellants, stress corrosion cracking, marine corrosion, and ocean technology. (J.R.D.)

For abstracts of individual papers see: 16413–16417, and 16582.

16413 CORROSION TESTING OF MATERIALS IN LIQUID PROPELLANT SYSTEMS. Meyer, F. H. (Air Force Materials Lab., Wright-Patterson AFB, Ohio); Toy, S. M.; Tiner, N. A.; Lorenz, P. pp 2-9 of Proceedings of the First Joint Aerospace and Marine Corrosion Technology Seminar, Los Angeles, California, July 10–12, 1968. Houston, Tex.; National Association of Corrosion Engineers (1969).

From 1st Joint Aerospace and Marine Corrosion Technology Seminar, Los Angeles, Calif. See CONF-680732.

The corrosion behavior of aluminum, stainless steel, and titanium alloys in liquid fluorine and fluorine-containing oxidizers is discussed. The effects of temperature, applied stress, and pressurization are considered. Results of tests are included for static and dynamic tests on Al, 17-4 PH stainless steel, and Ti-base Al–V alloys in N_2O_4, ClF_3, F_2. (J.R.D.)

16414 CORROSION BEHAVIOR OF MATERIALS IN PROPELLANT EXHAUST GASES. Saul, A. M.; Moody, H. L. (Philco-Ford Corp., Newport Beach, Calif.). pp 27-33 of Proceedings of the First Joint Aerospace and Marine Corrosion Technology Seminar, Los Angeles, California, July 10–12, 1968. Houston, Tex.; National Association of Corrosion Engineers (1969).

From 1st Joint Aerospace and Marine Corrosion Technology Seminar, Los Angeles, Calif. See CONF-680732.

Chemical and thermal effects of propellant gases on rocket nozzles are examined. Solid and liquid propellant compositions are tabulated along with compositions of hybrid propellants. Combustion temperatures and chemical species of combustion products are also tabulated. (J.R.D.)

16415 SOLUTIONS TO SOME STRESS CORROSION CRACKING PROBLEMS IN AEROSPACE SITUATIONS. Stanley, James K. (Aerospace Corp., El Segundo, Calif.). pp 36-43 of Proceedings of the First Joint Aerospace and Marine Corrosion Technology Seminar, Los Angeles, California, July 10–12, 1968. Houston, Tex.; National Association of Corrosion Engineers (1969).

From 1st Joint Aerospace and Marine Corrosion Technology Seminar, Los Angeles, Calif. See CONF-680732.

Practical implications of stress corrosion cracking are discussed. Methods for identifying stress corrosion are described and ways of eliminating or circumventing failures from this cause are discussed. The materials considered include high-strength steels and stainless steels. (J.R.D.)

16416 CORROSION STUDIES ON FORGED BERYLLIUM. McKay, T. L.; Gilpin, C. B.; Tiner, Nathan A. (McDonnell Douglas Corp., Newport Beach, Calif.). pp 48-53 of Proceedings of the First Joint Aerospace and Marine Corrosion Technology Seminar, Los Angeles, California, July 10–12, 1968. Houston, Tex.; National Association of Corrosion Engineers (1969).

From 1st Joint Aerospace and Marine Corrosion Technology Seminar, Los Angeles, Calif. See CONF-680732.

Results of tests in which forged Be shapes were exposed to corrosion by aqueous salts at ambient and elevated temperatures and in stressed and unstressed conditions are summarized. It was found that Be is resistant to corrosion by water but is susceptible to corrosion by chloride salts. Coatings offer good protection. Be is not susceptible to stress corrosion. (J.R.D.)

16417 USE OF ELECTROCHEMICAL POLARIZATION TECHNIQUES FOR CORROSION STUDIES IN AQUEOUS SYSTEMS AT HIGH TEMPERATURE AND PRESSURE. Wilde, B. E. (General Electric Vallecitos Nucleonics Lab., Pleasanton, Calif.). pp 68-72 of Proceedings of the First Joint Aerospace and Marine Corrosion Technology Seminar, Los Angeles, California, July 10–12, 1968. Houston, Tex.; National Association of Corrosion Engineers (1969).

From 1st Joint Aerospace and Marine Corrosion Technology Seminar, Los Angeles, Calif. See CONF-680732.

Methods of conducting in situ electrochemical studies of corrosion at temperatures up to 317°C in reactor cooling systems are described. The technique can be used to obtain accurate rate/time data in high resistance aqueous media down to corrosion rates of 10^{-4} mils per year. Data are included on 304 stainless steel corrosion rates in water. (J.R.D.)

16418 AREAS OF APPLICATION FOR NICKEL–MOLYBDENUM AND NICKEL–CHROMIUM–MOLYBDENUM ALLOYS IN THE CHEMICAL INDUSTRY. Shvarts, G. L.; Makarova, L. S.; Gerasimenko, G. I. Khim. Neft. Mashinostr.; No. 5, 20-2 (1969). (In Russian).

The composition and properties of the new corrosion resistant alloys N70M27F [70Ni–27Mo–1.5V] and 0Kh15N65M16V [15Cr–65Ni–16Mo containing Co ≤ 2.5, and V ≤ 0.35%] are described. The corrosion resistance of the alloys and their welded joints in various aggressive media are reported. Heat-treatment regimes for welded joints to avoid intercrystalline corrosion are given. (Referativnyi Zh.)

Preparation and Fabrication

Refer also to abstracts 15749 and 18167.

16419 (AGARD-CP-73-71, Paper 18) MEETING REQUIREMENTS FOR HIGH TEMPERATURE GAS TURBINES, A CHALLENGE TO METALLURGISTS. Coutsouradis, D. (Centre National de Recherches Metallurgiques, Liege (Belgium)). 17p.

From High temperature turbines.

Current approaches used for the improvement of cobalt and nickel-base alloys are reviewed and illustrated. The scope is not limited to an increase in strength but also to ensuring structural stability, hot corrosion resistance, and coatability. Chemistry can be better controlled to promote strength, stability or corrosion resistance. Control of processing variables such as hot deformation of normally cast alloys, controlled and directional solidification of conventional or eutectic type alloys, and powder metallurgy techniques, are evaluated. Although all of these approaches have not always fulfilled their expectations, their possibilities and limitations can be better defined. (auth)

16420 (AGARD-CP-73-71, Paper 21) PROGRESS IN THE MATERIALS FOR HIGH TEMPERATURE TURBINES. Brunetaud, Robert (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Corbeil (France)). 8p. (In French).

From High temperature turbines.

The turbine blades and vanes work in complex conditions with creep, thermal fatigue, corrosion, and erosion. Cobalt base and nickel base alloys are used for these parts. Progress with new processes such as vacuum melting, vacuum precision casting, and unidirectional solidification is reported. Advantages are possible with the use of Nb alloys but the problems of the coatings are not well resolved. For the discs, low cycle fatigue has more effect than creep. In general, modified alloys from materials used for blades are often chosen but the fabrication problems are not easily solved. New techniques such as isothermal forging or use of wrought sintered products are likely to be effective in producing greatly improved products. (auth)

16421 (N-70-36774) DETERMINATION OF WELDABILITY AND ELEVATED-TEMPERATURE STABILITY OF REFRACTORY METAL ALLOYS. 1. WELDABILITY OF REFRACTORY METAL ALLOYS. Lessmann, G. G. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Aug 1970. Contract NAS3-2540. 292p. (NASA-CR-1607; WANL-PR-(P)-13). NTIS.

Refractory metal alloys commercially available and several experimental alloys were included in this program. Both sheet and plate were welded by GTA (gas-tungsten-arc) and EB (electron beam) weld processes. Tantalum alloys showed excellent weldability, followed by the niobium alloy which showed variable weldability, followed by the tungsten alloys which showed generally poor weldability. Weldability was interpreted in terms of its effect on mechanical and metallurgical characteristics rather than merely the ease of joining. Reliable methods were developed for control of the weld atmosphere. A statistical sampling showed that the refractory metal alloys could be welded without contamination. The factors causing weld porosity were determined and procedures to eliminate it were developed to avoid it. The importance of balance between matrix and grain boundary strength in high temperature applications was demonstrated. Alloys with large weld grains (solid solution alloys), low recrystallization temperatures, and relatively weak grain boundaries (yttrium modified alloys) had the least desirable tensile fracture characteristics. (auth) (STAR)

16422 ELECTROPOLISHING PURE VANADIUM. Pelleg, J. (Nuclear Research Center, Negev, Israel). Metallography; 3: 457-60(Dec 1970).

An electropolishing method for polycrystalline vanadium is described that provides a high-quality surface and one that is free of cold work. (G.M.C.)

16423 FRICTION WELDING STAINLESS STEEL TO ZIRCALOY-2. Kilbride, J.; Adams, D. F. Weld. Metal. Fabr.; 39: 26-35(Jan 1971).

An investigation was carried out on the behavior of friction welded transition joints at room temperature and also at 300°C for service in SGHWR's. Square end and hole and cone preparations were analyzed. Results of tensile tests, stress rupture tests, and oxidation tests are tabulated and discussed. It is concluded that the cup and cone joint preparation used with friction welds of Zircaloy-2 to stainless steel gives high-strength joints with satisfactory corrosion resistance, stress rupture life and tensile properties under SGHWR conditions. (UK)

16424 NICKEL–COBALT–CADMIUM DEPOSITION: TERNARY ALLOY FROM SULFATE BATHS. Dambal, R. P.; Ramachar, T. L. (Electrochemical Lab., Bangalore, India). Metal Finish.; 67: No. 5, 68-9(1969).

Detailed studies were made on the deposition of binary alloys of cadmium with nickel and cobalt from sulfate baths. During the work on the effect of nickel additions in the plating of the latter alloy, the feasibility of ternary alloy deposition was indicated. A digest of detailed investigations on ternary alloy deposition from sulfate baths is presented. (Indian Sci. Abstr.)

16425 SPARK MACHINING OF BERYLLIUM. Brewer, A. W. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Microstructures; 25-8(Aug-Sep 1970).

An investigation was conducted to ascertain the effects of spark-machining (EDM) on beryllium ingot sheet. Specific emphasis was placed on the depth of damage caused by the spark-machining process. It was found that the EDM process generally caused less damage to the beryllium surface than is caused by the single point machining process now used. However, EDM is slower in removing metal than a lathe. (auth)

16426 REFRACTORY METAL SEPARATION BY FUSED SALT ELECTROLYSIS. Petenev, O. S.; Ivanovskii, L. E. Tr.

XUM

Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 14, 106-11 (1970). (In Russian).

An expression was obtained for the coefficient of separation of refractory metals by cathodic precipitation under near-equilibrium conditions. Values were calculated for these conditions. A search was conducted in the literature for information concerning the electrochemical properties of refractory metals and methods of semiquantitatively determining the degree of efficiency in separation of one metal from others by electrolysis. (tr-auth)

16427 PROCESS FOR TREATING THE SURFACE OF ZIRCONIUM AND ZIRCONIUM ALLOY BODIES. (to Siemens AG). British Patent 1,220,118. 20 Jan 1971. Priority date 10 May 1967, Germany.

A process is described for polishing surfaces of Zr or Zr alloys. The piece to be polished acts as the anode in an electrolytic cell containing mixed perchloric, acetic, and hydrochloric acids in optimum proportions. Chloroacetic acid may also be added. The current density used is 20 to 150 A/dm^2 at 25°C. (J.R.D.)

16428 MANUFACTURE OF IMPROVED NUCLEAR FUELS. Colombie, Michel; Foure, Michel (to Compagnie pour l'Etude la Realisation de Combustibles Atomiques). U. S. Patent 3,545,966. 8 Dec 1970. Filed 27 Feb 1968.

Fine grained nuclear fuels having stable dimensions under working conditions in nuclear reactors were made. Uranium and its alloys with metals such as molybdenum, chromium, silicon, and germanium were alloyed with small amounts of boron and beryllium by a process which involved controlled cooling in a particular temperature range. Advantages are secured by multiplying the number of grains per unit volume in the fuel. (Offic. Gaz.)

16429 CERTAIN PECULIARITIES OF THE CATHODE-RAY MELTING PROCESS FOR THE PURIFICATION OF REFRACTORY METALS. Efimov, V. E. Izv. Akad. Nauk SSSR, Metal.; No. 3, 49-52(May-Jun 1970). (In Russian).

Results of investigations show that to obtain high-purity Nb by electron beam melting the metal must remain a liquid for about 5½ min; for Ta the time is 2.5 min. Change of heating rate has an effect on purification when the fusion rate is slowed. Refining processes continue throughout the liquid stage. The probable mechanism of impurity removal constitutes recombination and subsequent evaporation of impurity compounds. It was found that smaller diameter bars have thinner melt layers and a degree of purification can be attained by addition of a single remeltable ceramic charge. Successive additions of remeltable charges provide complete purification. (tr-auth)

16430 GRAIN SIZE REFINEMENT IN A TANTALUM INGOT. Friedman, Gerald I. (Whittaker Corp., Concord, Mass.). Met. Trans.; 2: 337-41(Jan 1971).

The grain size of a cast high-purity tantalum ingot was refined by upsetting 52% at 500°F, extruding 52% at room temperature to original size, and annealing at 2000 to 2200°F. Final grain size in an ingot processed in this manner should fall within the range of ASTM 5 to 8. (auth)

16431 PREPARATION OF SMALL NIOBIUM–25 PERCENT ZIRCONIUM ALLOY WIRES FOR ELECTRON MICROSCOPY. Thompson, S. J.; Flewitt, P. E. J. (Central Electricity Generating Board, Cockfosters, Eng.). Metallography; 3: 477-80 (Dec 1970).

A simple, reproducible method for preparing longitudinal and transverse section foils from 0.25-mm diameter niobium–25% zirconium alloy wires by ion beam thinning is described. (G.M.C.)

16432 HOT ISOSTATIC PROCESSING. Boyer, C. B.; Hatfield, J. E.; Orcutt, F. D. (Battelle Memorial Inst., Columbus, Ohio). Mech. Eng.; 93: No. 2, 33-9(Feb 1971).

Development of methods for hot isostatic compacting used in fabrication of ceramic, cermet, and metal articles is described. The process can be applied to powder compaction, consolidation of materials, and to solid-state joining of metal and ceramic components. The application of large, cold-wall pressure vessels for production of gas pressures up to 150,000 at 5000°F for materials fabrication is described. (J.R.D.)

16433 RECENT PROGRESS IN THE CASTING OF CRITICAL COMPONENTS IN MAGNESIUM–ZINC–ZIRCONIUM–RARE-EARTH ALLOYS. Camurri, C. Fonderia Ital.; 18: 456-8(Dec 1969). (In Italian).

The production of a 12-cylinder engine block for a formula 1 racing car using three alloys of the Mg–Zn–Zr–rare earth-type is described. Precautions necessary during production and in use are detailed; these included an electrolytic surface protection layer during fusion, specially inhibited sand for mould and cores, resin impregnation of the casting, protection of Fe inserts from Mg during Zn and Cd plating, and inhibition of the cooling water during use. (Metals Abstr.)

16434 ELECTROSLAG-MELTED MOLYBDENUM. Calvert, E. D.; Beall, R. A.; Kato, H. (Bureau of Mines, Albany, Oreg.). J. Less-Common Metals; 23: 129-51(Feb 1971).

The preparation of molybdenum ingots by electroslag melting is discussed, ingot characteristics are described, and results of mechanical testing of wrought products are compared with those from similar material prepared from arc-cast molybdenum. Thermochemical considerations limited the choice of slag materials to a few high-temperature oxides; of these, yttrium oxide was found to be best suited for use in molybdenum melting. The use of additives to the slag was found necessary to minimize the occurrence of excessive oxide films at ingot grain boundaries. Changes in ingot surface and structure were found to be responsive to changes in such melting variables as power input, electrode spacing, electrode polarity, and environmental pressure conditions. Pressure conditions, electrode polarity, and the slag additives carbon and yttrium, were found to influence the oxygen level and occurrence of extraneous oxide phases in the ingots. Excellent surface conditions were normally associated with the electroslag ingots; as a direct result, much less waste in conditioning ingots for fabrication was encountered than was normal for arc-cast ingots. Additional material economy resulted from the unusually low temperature at which the electroslag ingots can be fabricated. Sheet fabricated from the electroslag-melted ingots appeared to have mechanical properties superior to those of sheet prepared from similar arc-cast ingots. (auth)

16435 NICKEL ACTIVATED SINTERING OF TUNGSTEN. Fletcher, G.; James, M. R.; Moon, J. R. (Univ. of Nottingham, Eng.). Scr. Met.; 5: 105-7(Feb 1971).

The sintering of tungsten powder was greatly enhanced by the presence of small quantities of nickel. This process was further studied by using wire model systems. The results were consistent only with a sintering mechanism controlled by the rate of surface diffusion. (G.M.C.)

Properties Evaluations

Refer also to abstracts 15627, 15839, 15846, 15853, 16582, 16595, 16596, 17308, 17324, 18100, 18139, 18171, 18253, 18254, and 18256.

16436 (AD-710635) REVIEW OF Ti-6Al-6V-2Sn FATIGUE BEHAVIOR. Research Report, January 15–May 1, 1970. Amateau, Maurice F.; Kendall, E. George (Aerospace Corp., El Segundo, Calif.). 15 Jul 1970. Contract F04701-70-C-0059. 113p. (TR-59(6250-10)-6; SAMSO-TR-70-275). NTIS.

A compilation of Ti–6Al–6V–2Sn fatigue data is presented for a number of different material forms and conditions. Stress versus log cycles to failure (S–N) curves or master diagrams, or both, for annealed, solution-treated and aged, and thermomechanically worked materials are included. The data are organized according to material form, such as sheet, plate, rolled bar, forging, and extrusion. Crack propagation behavior in air and salt water is also included. The general characteristics of Ti–6Al–6V–2Sn fatigue are discussed and compared with those for other titanium alloys. (auth) (USGRDR)

16437 (AGARD-CP-73-71, Paper 19) FIBER STRENGTHENED NICKEL-BASE ALLOY. Morris, A. W. H.; Burwood-Smith, A. (National Gas Turbine Establishment, Farnborough (England)). 15p.

From High Temperature turbines.

The development and application of high temperature composites for gas turbine blading is discussed. Of the currently available reinforcements examined, only tungsten-5% rhenium wire affords acceptable stability in nickel-base alloys and a satisfactory increase in stress-rupture strength, but only by incurring a weight penalty. The maximum volume fraction reinforcement is controlled by composite density and blade geometry; at the low levels imposed the advantage of reinforcement is nominal, particularly in a cooled blade. If adopted, fiber reinforcement is likely to be used in solid blades in engine stages where cooling is prohibitive and then only as a selected area reinforcement. The whole question of application may rest on the thermal fatigue behavior. Results of laboratory tests on cylindrical specimens indicate very poor thermal fatigue crack resistance. Application of the newer low density single crystal alumina fiber is also discussed. (auth)

16438 (IN-1295) ELECTROLYTIC BEHAVIOR OF NUCLEAR FUEL CLADDING ALLOYS. Lewis, L. C.; Musgrave, B. C. (Idaho Nuclear Corp., Idaho Falls). Jan 1971. Contract AT-(10-1)-1230. 38p. Dep. NTIS.

The electrochemical properties of aluminum, nickel-based,

and stainless steel cladding alloys for nuclear fuels were examined using a galvanostat. The alloys were Types 304, 304L, 347, 309, and 316 stainless steel, Nichrome, and Types 1100, 2219, 6061, and X8001 aluminum. Special experimental aluminum–silicon alloys were also tested. In addition, a sample of Type 304 stainless steel irradiated in EBR-II was examined. Surface effects which were related to the conditions of irradiation, and which did not exist with unirradiated material, were discovered with the irradiated Type 304 stainless steel. It was demonstrated that the galvanostat could be used for an investigation of catalyst activity, for identification of alloys, and for the study of surface effects. Electrolytic dissolution was proven to be possible for all alloys examined. (auth)

16439 (KFK–1290) INVESTIGATION OF WEAR AND FRICTION BETWEEN FUEL ROD BUNDLES AND SPACER GRIDS IN SODIUM. Kleefeldt, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Oct 1970. 20p. (In German). Dep. NTIS (U. S. Sales Only).

Results of experiments in sodium in which the friction between fuel element bundle and spacer grids were investigated up to temperatures of 680°C are described. The relative axial movement between the fuel pins and the spacers, which results from different heat expansion in the fuel element, was simulated mechanically using an eccentric drive. The frictional forces produced during this process were 5 to 20 kg per spacer grid in sodium and higher in air and argon. For two different spacer designs a critical frictional force R_{crit} ≈55 kg and 60 to 80 kg, respectively, was determined. If the frictional force exceeds this critical value due to a lack of clearance, the bowing of the grid leads to a clamping effect and to plastic deformation. Repetitive movement of the bundle causes the spacer grid to rupture. The increase in clearance by wear is less than 0.02 mm. This means it is much below the tolerance level required in fabrication and operation. Diffusion welding of joints in sodium was not detectable after seven days of shutdown period at 600°C. Discussions are included on the advantages and drawbacks of the selected methods of spacer grid fastening. (auth)

16440 (LA–4559) ENTHALPIES OF SOLUTION OF SELECTED ELEMENTS IN SEVERAL LIQUID METAL SOLUTIONS. Bowerson, David F. (Los Alamos Scientific Lab., N. Mex.). Dec 1970. Contract W-7405-eng-36. 9p. Dep. NTIS.

The calculation of partial molar enthalpies and entropies of elements that form simple eutectic-type binary systems with plutonium are reviewed. The partial molar enthalpies of solution of several elements that form compounds or solid solutions with plutonium have been calculated by regular solution theory from solubility data. The calculated enthalpies are (in kcal/mole): carbon, 10.5; thulium, 9.2; manganese, 4.8; rhenium, 10.5; zirconium, 4.2; titanium, 4.1 from 700 to 750°C, and 5.3 from 800 to 1000°C. The regular solution theory has also been applied to other systems to calculate enthalpies from published solubility data. These results are compared with an empirical approach. (auth)

16441 (RFP–996) TEMPERATURE-INDUCED SHAPE MEMORY IN POLYCRYSTALLINE URANIUM-BASE NIOBIUM ALLOYS: CHARACTERIZATION. Jackson, Ross J.; Johns, Wilbur L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 23 Sep 1970. Contract AT(29-1)-1106. 7p. Dep. NTIS.

Certain polycrystalline uranium-base niobium alloys undergo unusual shape changes on heating or cooling. The shape changes were athermal and under certain conditions completely reversible. This behavior is referred to as temperature-induced shape memory. The shape changes occurred in the composition range of 6 to 21 atomic % Nb and in the temperature range of –200 to +400°C. For the alloy to exhibit shape memory it must first be cooled rapidly from the gamma region and then subjected to a plastic deformation below 425°C. The effects of composition, temperature, time at temperature, and types of strain, on the shape memory, are discussed. (auth)

16442 (RFP–1566) EFFECT OF WATER VAPOR, REDUCED OXYGEN CONCENTRATIONS, AND SOLVENT VAPORS ON PLUTONIUM IGNITION. Musgrave, Larry E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 28 Jan 1971. Contract AT(29-1)-1106. 7p. Dep. NTIS.

The effects of water vapor, reduced oxygen concentration, and chlorinated solvent vapor on the ignition of various sizes of samples of unalloyed and alloyed plutonium have been studied. Storing unalloyed plutonium lathe turnings in moist atmospheres reduces the ignition temperature, but storing plutonium–1- wt% gallium alloy lathe turnings in moist atmospheres raises the ignition temperature regardless of the moisture level. Adding nitrogen to reduce the oxygen concentration does not, generally, change the ignition temperature. However, the intensity of the reaction is reduced, and at low concentrations ignition is prevented. The presence of carbon tetrachloride vapor lowers the ignition temperature of plutonium, but the presence of perchloroethylene vapor has no effect. (auth)

16443 (SwRI–1228-P-2-47) STUDIES OF THE FATIGUE STRENGTH OF PRESSURE VESSELS. EFFECTS OF WELD DEFECTS ON THE FATIGUE STRENGTH OF A302 GRADE B STEEL. Technical Summary Report. Grigory, S. C.; Blackstone, W. R.; DeHart, R. C. (Southwest Research Inst., San Antonio, Tex.). 15 Dec 1970. Contract AT(11-1)-1228. 89p. Dep. NTIS.

Results of an investigation to determine the effect of weld defects on the plastic fatigue strength of A302 Grade B pressure vessel steel are presented. Surface and subsurface defects were generated by designing weld joints which would have the defects desired while otherwise good welding practice was used. The types of defects simulated were lack of penetration, lack of fusion and slag inclusion. Specimens with sound weldments and no weldments were also tested and used as a base line for comparison of data. Constant load amplitude fatigue testing was used throughout most of the program. (auth)

16444 (WAPD-TM–936) FRACTOGRAPHIC STUDY OF ZIRCALOY-4 WEDGE-OPENING-LOAD PLANE-STRAIN SPECIMENS. Goldberg, S. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec 1970. Contract AT-11-1-GEN-14. 24p. Dep. NTIS.

An investigation of the fracture behavior of four unirradiated wedge opening load (WOL) plane-strain Zircaloy-4 samples was performed utilizing both electron fractography and optical metallography. Hydrided and unhydrided specimens were fractured in Mode I (tensile component of stress applied normal to crack face) at 100 and 175°F. It was found that the unhydrided samples failed predominantly by microvoid coalescence, whereas the hydrided specimens fractured primarily by cleavage and quasi-cleavage mechanisms. In both cases the fracture characteristic was more intergranular than transgranular. It was also noted that increasing amounts of hydrogen tended to minimize local surface variations in the mode of fracture. Because most of the fracture was intergranular and the hydrides appear at the grain boundaries, it is believed that much of the observed cleavage is through the hydrides rather than in the Zircaloy. (auth)

16445 (WHAN-SA–8) NEW CANDIDATE LMFBR CLADDING ALLOY. Laidler, J. J. (WADCO Corp., Richland, Wash.). 13 Nov 1970. Contract AT(45-1)-2170. 17p. (CONF-701102–12). Dep. NTIS.

From Meeting of the American Nuclear Society, Washington, D. C.

Properties of thermomechanically treated type 348 SST for LMFBR cladding applications are reviewed. It is noted that suitable treatment of this material produces NbC precipitation at dislocations and stacking faults which results in improved elevated-temperature mechanical properties. A high concentration of sinks and traps for point defects are found in the 348 microstructure. (J.R.D.)

16446 DEFORMATION OF TITANIUM BY SURFACE OXIDATION. Kellerer, Helmut; Wingert, Lew (Boeing Co., Seattle). Met. Trans.; 2: 113-15(Jan 1971).

The length changes caused by oxidation in air of Ti–6Al–4V were investigated at temperatures between 800 and 1040°C. In 3.1 mm-thick specimens a 60 min exposure at 950°C resulted in a net expansion of 0.7%. If oxidation and the corresponding expansion were restricted to one surface of a sheet metal specimen a bimetallic strip effect was obtained and the specimens deformed into the shape of an arc. Several mechanisms can contribute to deformation during oxidation. The increase of the c lattice parameter with increasing oxygen content accounted for most of the observed volume expansion. Because oxygen stabilized α, the surface layers contained a higher than equilibrium α concentration. Higher thermal expansion of α and its larger volume per unit cell caused additional deformation. These mechanisms apparently can introduce surface stresses up to several kg per sq mm which result in extensive creep deformation. (auth)

16447 COLUMBIUM BASE ALLOY. Schussler, Mortimer (to Cabot Corp.). British Patent 1,211,425. 4 Nov 1970. Filed 27 May 1968.

Reference is made to a niobium alloy containing V and Zr, with beneficiating amounts of C. Such an alloy may have nuclear reactor applications. Difficulties with regard to mechanical, physical, and chemical properties of Nb alloys are briefly outlined. The alloy described comprises at least 92% Nb, 5 to 5.23% V, 1 to 1.13% Zr, and 0.005 to 0.04% C, and is stated to be cold rollable and very ductile. Undesirable impurities are indicated. The alloy shows favorable nuclear properties for thermal reactor use, and good corrosion resistance to hot water and steam. It also shows satisfactory strength properties. (UK)

XUM

16448 CHEMISORPTION OF NITROUS OXIDE AT LOW PRESSURES BY RHENIUM. Gasser, R. P. H.; Marsay, C. J. (Oxford Univ.). Surface Sci.; 20: 116-22(Mar 1970).

The adsorption of nitrous oxide by a rhenium filament was studied at filament temperatures of 298, 1000, and 1220°K. The adsorption proceeded by the abstraction of the oxygen atom from the nitrous oxide molecule and the nitrogen thus generated appeared in the gas phase. No nitrogen adsorption was detectable. The initial sticking probability at 298°K was 0.45 and this value was maintained up to half the maximum coverage, 5.7×10^{14} atoms cm^{-2}. The shape of the sticking probability curve is attributed to the formation of a mobile precursor to adsorption. The initial sticking probability was less at the higher temperatures. At filament temperatures above 1600°K rhenium decomposed nitrous oxide continuously. The reaction probably involves the desorption of oxygen atoms from the surface. (auth)

16449 REACTION OF OXYGEN WITH RHENIUM. Gasser, R. P. H.; Marsay, C. J. (Oxford Univ.). Surface Sci.; 20: 107-15(Mar 1970).

The sticking probability of oxygen on a clean rhenium filament was 0.3 both at 298 and 1000°K. At the lower temperature, the shape of the sticking probability curve was attributed to the formation of a short-lived precursor to adsorption followed by chemisorption onto adjacent pairs of sites in an immobile layer. The catalysis of the isotope exchange reaction $^{36}O_2 + {}^{32}O_2 = 2\ {}^{34}O_2$, at rhenium filament temperatures between 1000 and 2100°K, was attributed to the desorption from the filament of oxygen atoms which reacted at the walls of the apparatus. (auth)

16450 FIELD EMISSION STUDY OF CARBON MONOXIDE ON hcp METALS RHENIUM AND RUTHENIUM. Klein, Ralph (National Bureau of Standards, Washington, D. C.). Surface Sci.; 20: 1-17(Mar 1970).

The surface migration, work function increments, and desorption of carbon monoxide on two hcp metals, rhenium and ruthenium, were observed with field emission techniques. Carbon monoxide was weakly bound to ruthenium and more strongly bound to rhenium. For a complete monolayer, the work function increment was 1.3 eV for ruthenium and 0.8 eV for rhenium. Surface migration commenced at a readily observable rate at about 125°K on ruthenium. The migration was characterized by a sharp boundary that became boundary free in the later stages. Because desorption preceded surface migration for CO on rhenium, the onset of migration was ill defined. Two well defined binding states, α and β were seen for CO on rhenium. (auth)

16451 SUPERPLASTIC DEFORMATION IN A EUTECTIC ALLOY OF CADMIUM AND ZINC. Merriman, Edmund Alan. Uubana, Ill.; Univ. of Illinois (1970). 114p. University Microfilms Order No. 70-21,017.

Thesis.

The eutectic cadmium–zinc alloy was shown to be superplastic, being easily elongated 1774% with the strain rate sensitivity exponent, $m = d(\log \sigma)/d(\log \dot{\epsilon})$, reaching ~0.6. The deformation behavior was investigated in specimens with grain sizes from 2.0 to 12.6 microns, at 150 to 255°C and strain rates of 5×10^{-6} to 50/minute to determine which deformation mechanisms were responsible for superplastic flow in Cd–Zn. The strain rate dependence of stress was found to be typical of that observed in low-melting, superplastic alloys, high at intermediate rates, decreasing at low and high rates. X-ray diffraction patterns from superplastically deformed specimens revealed no subgrain formation, internal stresses, or changes in rolling texture. Studies of internal grain shapes and of prepolished, deformed surfaces showed that grain boundary sliding was an important superplastic deformation mechanism in Cd–Zn and that boundary migration (primarily at low strain rates) and grain rotation (particularly at intermediate to high rates) were also occurring. The activation energy for superplastic deformation in Cd–Zn (after correction for the effect of decreasing elastic modulus with increasing temperature) was determined to be 19.9 kcal/mole for temperatures from 150 to 215°C, and 30.7 kcal/mole for temperatures from 215 to 255°C. These values were approximately equal to the activation energies for self diffusion and prismatic slip, respectively in cadmium. The strain rate was found to be inversely proportional to the grain diameter to the 1.0 to 1.6 power, the greater dependence occurring for conditions of high m. The value of the predicted strain rate and its dependence on stress, grain size, and temperature was calculated for several high temperature deformation mechanisms, modified for the case of very fine grain size. The theoretical predictions were compared with the experimental results in Cd–Zn. It was concluded that grain boundary sliding was the predominant mechanism of superplastic deformation in Cd–Zn and theoretical calculations suggested that grain boundary diffusion creep may contribute to the deformation as well. The grain boundary sliding was apparently controlled by accommodation mechanisms; the measured activation energies indicated that prismatic slip controlled the strain rate at high temperatures, and glide of dislocations that drag Zn atmospheres controlled the strain rate at low temperatures. It is proposed that as strain rate decreases to very low values in fine grained Cd–Zn, dislocations are no longer annihilated at the nearby grain boundaries, but instead climb and are annihilated within the grains. The resulting stress dependence of the dislocation array length causes the observed decrease in the value of m. This proposal could be applied to other superplastic alloys as well, to attempt to explain the generally observed low values of m at low strain rates. (Diss. Abstr. Int., B)

16452 COMPARISON OF HIGH-TEMPERATURE CREEP OF SOME HOMOGENEOUS IRON AND NICKEL ALLOYS. Hofmann, Rolf; Ilschner, Bernhard (Univ., Erlangen, Ger.). Z. Metallk.; 61: 942-6(Dec 1970). (In German).

Single phase alloys of the Fe–W, Fe–Si, Fe–Ni, and Ni–Cr systems were subjected to constant load tensile tests at 850°C. Creep strain was measured as a function of time, while the creep rate as a function of strain was used for evaluation. For the fcc alloys, the stationary creep rate was, as expected, much lower than for the bcc alloys. However, the stress dependence at low stresses for all alloys may be characterized by a σ^5-law. Elongation at fracture was much larger for the bcc alloys. Fracture strain and length of the transition creep range were determined as a function of stress. Anomalous (inverted) transition creep was observed, at low stresses, in Fe–W. (auth)

16453 THERMODYNAMICS OF STEEL DEOXIDATION BY CERIUM. Vladimirov, L. P. Izv. Akad. Nauk SSSR, Metal.; No. 3, 56-9(May-Jun 1970). (In Russian).

The thermodynamics of deoxidation of steel by Ce additions to liquid charges were calculated. Processes of polymorphic transformations occurring in the ferrous alloy by dissolution of Ce were calculated. Data on Ce concentrations in the melt were used to prepare equilibrium diagrams related to temperature. A hyperbolic relation was found between the equilibrium constants logarithm and the Ce concentration. It was shown that decreases in Ce concentration and temperature slow deoxidation rates. (tr-auth)

16454 CREEP OF YTTRIUM. Suganeev, Yu. S.; Shorshorov, M. Kh.; Yakutovich, M. V. Izv. Akad. Nauk SSSR, Metal.; No. 3, 132-8(May-Jun 1970). (In Russian).

Creep properties of Y at 595 to 700°C were investigated in the pressure range 0.28 to 4 kg/mm^2. The temperatures represent 0.39 to 0.47 Tm. Creep initiation at 10^{-4} to 10^{-8} sec^{-1} was studied. The first unstable stage of Y creep constitutes less than 0.2 to 0.4% deformation. The mechanism of crystal climb dislocation is suitable for explaining Y creep initiation. The relation of Y creep obtained by experiment is compatible with the creep formula. The initiation of creep in Y was found to be 11.4 kcal/mole. (tr-auth)

16455 EFFECTS OF RARE EARTHS ON THE STRUCTURE AND HIGH-TEMPERATURE STRENGTH OF COPPER AND COPPER–ZIRCONIUM ALLOYS. Korol'kov, A. M.; Gurova, L. M. Izv. Akad. Nauk SSSR, Metal.; No. 3, 165-70(May-Jun 1970). (In Russian).

The effects of rare earth metals on the high-temperature strength of Cu and Cu–Zr-bearing alloys were investigated. Copper is strengthened by rare earth additions. The elements Y, Ce, and Pr have the greatest effect on the strength of Cu at 400°C while La and Nd have less effect. The most heat-resistant alloy at 400°C is the alloy Cu–Zr containing 2.5 to 3% Zr. Dilute Cu-base alloys Cu–Zr–Ce and Cu–Zr–Y have high electric conductivities at about 80 to 85% of Cu and have good heat strengths at 400°C. Copper alloys containing 0.8 to 1.2% Zr and 0.7 to 0.85% Ce are recommended as electric conductors for high temperatures. (tr-auth)

16456 STUDIES OF THE MECHANICAL PROPERTIES OF Ti–Mo–Ni ALLOYS. Kalabukhova, S. V.; Mikheev, V. S. Izv. Akad. Nauk SSSR, Metal.; No. 3, 184-6(May-Jun 1970). (In Russian).

Investigation results show that the introduction of up to 0.2 wt % Ni in Ti greatly increases its solid-solution strength. The Ti–Ni alloy containing 8 wt % Ni has the highest strength in this binary system being equal to 100 kg/mm^2. The strength varies from a low at 4.5 wt % Ni to a high of 6.7 wt % Ni. The best combination of stability and plasticity is a Ti–Mo–Ni alloy in which the Mo–Ti ratio is 1 to 1 and the content of Mo plus Ni is 0.4 1.8 wt % in relation to Ti. These alloys show a strength of 79 to 88 kg/mm^2, elongation factor of 13.5 to 18%, and contraction factor of 25 to 30%. Alloys with Mo–Ni ratio at 3 to 1 and 1 to 1 and containing

10 wt % Mo plus Ni are friable; their strength is 146 to 150 kg/mm^2. (tr-auth)

16457 PHASE EQUILIBRIUM AND HIGH-TEMPERATURE STRENGTH OF Ti–Zr–Al ALLOYS. Nartova, T. T.; Shirokova, N. I. Izv. Akad. Nauk SSSR, Metal.; No. 3, 194-8(May-Jun 1970). (In Russian).

Phase equilibria in the quasiternary system Ti_3AlZr were studied. A polythermal cross section was prepared parallel to the Ti–Ti_3Al with constant 5% Zr. Composition-property relations of the Ti–Al system were confirmed. An isothermal cross section of the system Ti–Ti_3AlZr at 500°C established the presence of a single-phase solid solution region of Ti–Zr–Al and a narrow two-phase Ti–Ti_3Al region. Other studies showed that 86 Ti–9 Al–5 Zr alloys have maximum creep resistance. This alloy has a range of strength at 25°C of 100 kg/mm^2 and at 700 to 800°C 80 to 50 kg/mm^2. (tr-auth)

16458 HETEROGENEOUS KINETICS AT ELEVATED TEMPERATURES. Proceedings of an International Conference in Metallurgy and Materials Science Held at Philadelphia, September 8–10, 1969. Belton, G. R.; Worrell, W. L. (eds.). New York; Plenum Press (1970). 538p. $27.50. (CONF-690927).

Nineteen articles are included; separate abstracts were prepared for four. Two articles were previously abstracted in NSA as 24: 4261 and 38651. The remaining 13 articles contain information on: activated complex of surface reactions at high temperatures; adsorption and kinetics at elevated temperatures; concept of thermodynamic activity of atomic species in heterogeneous kinetics; dissociation of gaseous molecules on solid surfaces at elevated temperatures; electrochemical studies of heterogeneous kinetics at elevated temperatures; kinetics of surface oxidation of metals by solid electrolyte techniques; growth of highly defective scales; chemical diffusion in Wuestite and chromium-doped manganous oxide; kinetics of oxidation of liquid Cu and the effects of interfacial silica; reactions of liquid Fe and its alloys with pure O; interaction of CO and liquid Fe; steady-state electrochemical cell study of kinetics of reaction of water vapor with liquid Pb–Te alloys; and importance of macroscopic transport phenomena in gas–solid reactions. (P.C.H.)

For abstracts of individual papers see: 15645, 16410, 16459, and 16460.

16459 KINETICS OF THE ATTACK OF REFRACTORY MATERIALS BY DISSOCIATED GASES. Rosner, Daniel E.; Allendorf, H. D. (AeroChem Research Labs., Inc., Princeton, N. J.). pp 231-51 of Heterogeneous Kinetics at Elevated Temperatures. /Belton, G. R. (ed.). New York; Plenum Press (1970).

From International Conference on Heterogeneous Kinetics at Elevated Temperatures, Philadelphia, Pa. See CONF-690927.

The production and detection of molecular fragments and recent experimental results on the O-atom, Cl-atom, H-atom, and N-atom attack of polycrystalline refractory materials forming volatile oxides, chlorides, hydrides and nitrides at temperatures up to 3000°K and at reactant pressures in the range 10^{-4} to 10^{-1} torr were surveyed. Emphasis was placed on the reactivity of tungsten, molybdenum, rhenium, graphite, boron, boron nitride, and silicon carbide in dissociated gases, and simple mixtures thereof. A discussion of mechanistic implications of the results and current extensions of the techniques to other gas/solid reactions involving free radicals (e.g., OH, F) of both fundamental and applied interest is included. (48 references). (P.C.H.)

16460 KINETIC STUDIES AT TEMPERATURES NEAR 4000°K USING THE FALLING SPECIMEN TECHNIQUE: THE REACTION $Zr(l) + O_2(g) \rightarrow ZrO_2(l)$. Nelson, Lloyd S.; Levine, Herman S. (Sandia Labs., Albuquerque, N. Mex.). pp 503-17 of Heterogeneous Kinetics at Elevated Temperatures. /Belton, G. R. (ed.). New York; Plenum Press (1970).

From International Conference on Heterogeneous Kinetics at Elevated Temperatures, Philadelphia, Pa. See CONF-690927.

Submillimeter samples of reactive materials have been studied at the temperatures near 4000°K by a free fall technique. This technique eliminates containment problems, yet permits accurate measurements to be made at temperatures where severe experimental difficulties are normally encountered. The laser-initiated combustion of molten Zr in gaseous O_2 was used as an example of the free fall technique. The reaction was studied as it occurred by photographic, spectroscopic, and pyrometric techniques, and the specimens were studied by gravimetric techniques at room temperature, either after being quenched during the reaction in liquid argon or after oxidizing completely. The droplets retain metal as they burn near their boiling temperature in pure oxygen near atmospheric pressure and lose metal when burning temperatures are lowered by reducing the oxygen concentration. This is explained by the return of vaporized oxide via condensation and coalescence from a spherical layer of oxide fog that surrounds the parent droplets during combustion. (auth)

16461 DEFORMATION OF Nb-W SINGLE CRYSTALS: ATHERMAL SOLID SOLUTION STRENGTHENING. Koss, Donald A. (Pratt and Whitney Aircraft, Middletown, Conn.). Met. Trans.; 2: 245-8(Jan 1971).

The athermal component of the flow stress of single crystals of niobium and four substitutional solid solution strengthened Nb-W alloys (1, 3, 6, and 15 at. %) was measured. The magnitude of the athermal stress was obtained by the method utilizing the temperature dependence of the flow stress and by a stress relaxation method. The agreement between these two methods is good. Athermal strengthening was a linear function of concentration over most of the composition range. No current athermal hardening theory is completely consistent with the experimental results. (auth)

16462 RHEOLOGICAL PROPERTIES OF ANNEALED TANTALUM. Hoge, K. G. (Univ. of California, Livermore); Gillis, P. P. Met. Trans.; 2: 261-4(Jan 1971).

The influence of strain rate on the mechanical behavior of 99.9% pure, fully recrystallized tantalum was examined. Stress-strain curves in tension were obtained from strain rates of 10^{-5} to almost 10^4 sec^{-1}. The rate dependence of the upper and lower yield stresses is closely predicted by the Johnston–Gilman model. However, the model does not adequately describe the postyield hardening behavior of the metal. (auth)

16463 EFFECT OF GAMMA–GAMMA PRIME MISMATCH, VOLUME FRACTION GAMMA PRIME, AND GAMMA PRIME MORPHOLOGY ON ELEVATED TEMPERATURE PROPERTIES OF Ni, 20 Cr, 5.5 Mo, Ti, Al ALLOYS. Maniar, Gunvant N.; Bridge, J. Edwin Jr. (Carpenter Tech. Corp., Reading, Pa.). Met. Trans.; 2: 95-102(Jan 1971).

This study was designed to provide a critical test for the postulate that the mismatch between the lattices of austenite (γ) and the age-hardening gamma-prime (γ') precipitates and the resultant coherency strains have a significant influence on the elevated temperature, particularly stress rupture, properties of a nickel-base superalloy. Two experimental alloys with a base analysis of Ni, 20 Cr, 5.5 Mo were designed with variable titanium and aluminum additions. To discern the effect of mismatch, an alloy without molybdenum was also experimented with. By manipulating the mismatch and volume fraction γ' by heat treatment and chemistry, it was shown that a lower γ-γ' mismatch indeed was beneficial to stress rupture life. Importance of volume fraction γ' on this elevated temperature was also established. (auth)

16464 EFFECT OF HELIUM ON THE STRESS-RUPTURE BEHAVIOR OF TYPE 316 STAINLESS STEEL. Garr, K. R. (Atomics International, Canoga Park, Calif.); Kramer, D.; Rhodes, C. G. Met. Trans.; 2: 269-75(Jan 1971).

Flat tensile samples of type 316 stainless steels with helium contents of 1.5×10^{-6} and 4.0×10^{-5} atom fraction, were stress-rupture tested in vacuum at 700°C. The presence of helium caused large reductions in rupture life and in elongation at failure. The amount of strain produced within the grains of helium-containing samples was a small fraction of the measured total elongation. The difference in these values is accounted for by extensive intergranular cracking. (auth)

16465 EMBRITTLEMENT OF TITANIUM ALLOYS BY LONG TIME, HIGH TEMPERATURE EXPOSURE. Shamblen, C. E. (General Electric Co., Cincinnati). Met. Trans.; 2: 277-80 (Jan 1971).

Alpha-stabilized titanium alloys are known to exhibit embrittlement after long-time exposures above ~800°F. The time-temperature dependency of this embrittlement phenomenon in the Ti–6Al–2Sn–4Zr–2Mo and Ti–5Al–6Sn–2Zr–1Mo–0.25Si alloys was observed using a substandard fracture mechanics test. Room temperature slow-bend tests of fatigue precracked Charpy specimens were used to monitor toughness degradation after unstressed thermal exposures in the temperature range of 800 to 1100°F for times to 5000 hr. The activation energy for the embrittlement process was found to be ~25 to 28 kcal per g mole, which approximated that for diffusion of aluminum or tin in α-Ti. The embrittlement is attributed to the Ti_3X (X = Al, Sn) phase with the rate controlling step that of diffusion controlled growth of the Ti_3X phase domains. The embrittlement process was reversible by heat treatment at temperatures above the $\alpha + Ti_3X$ two phase region. (auth)

16466 DENSITY AND VISCOSITY OF LIQUID Pu–U ALLOYS. Wittenberg, Layton J.; Ofte, Donald; Rohr, William G.; Rigney, David V. (Monsanto Research Corp., Miamisburg, Ohio). Met. Trans.; 2: 287-90(Jan 1971).

XUM

Density and viscosity determinations of liquid Pu-U alloys were made for five compositions, 5.5 to 28.5 wt % U, from near their liquidus temperatures to above 800°C. A vacuum pycnometric technique was used for the density determinations and an oscillating cup viscometer for the viscosity determinations. The partial molar volume of uranium was decreased approximately 15% in solutions containing up to 10.8 wt % U and approached the normal molar volume at higher uranium concentration. The partial molar volume of plutonium changed by only 1% over the entire composition range. The viscosity of the alloys up to 10.8% U increased more rapidly than predicted from the pure components. (auth)

16467 FIZICHESKAYA PRIRODA PLASTICHESKOI DEFORMATSII I RAZRUSHENIYA METALLOV. (Physical Nature of Plastic Deformation and Breakdown of Metals). Svechnikov, V. N. (ed.). Respublikanskii Mezhvedomstvennyi Sbornik, Seriya Metallofizika, Vypusk 21. Kiev; Naukova Dumka (1969). 136p.

Fifteen papers on the physical characteristics of plastic deformation and failure in metals are presented. A separate abstract was prepared for each of 2. Thirteen were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 16468 and 16469.

16468 EFFECT OF THE GEOMETRY OF PLASTIC DEFORMATION ON THE MECHANICAL PROPERTIES OF NIOBIUM SINGLE CRYSTALS. Gnuchev, V. S.; Larikov, L. N. (Inst. of Metal Physics, Moscow). pp 103-6 of Fizicheskaya Priroda Plasticheskoi Deformatsii i Razrusheniya Metallov. Svechnikov, V. N. (ed.). Kiev; Naukova Dumka (1969). (In Russian).

Measurements of ultimate tensile strength (UTS) were made on specimens of Nb single crystals deformed at room temperature (total deformation 85%) in two directions, i.e., rolled in the 110 plane in the [110] and [100] directions. For the [100] direction of rolling, the UTS was somewhat higher (46 kg/mm^2) than for crystals rolled in the [110] direction (36.8 kg/mm^2). This difference in UTS was maintained even after high-temperature annealing at 1050°C. (Referativnyi Zh.)

16469 EFFECT OF THERMO-MECHANICAL-MAGNETIC TREATMENT ON THE COERCIVE FORCE AND ELONGATION OF NICKEL AND IRON-GADOLINIUM ALLOYS. Borisova, V. I.; Dekhtyar, I. Ya.; Madatova, E. G. (Inst. of Metal Physics, Moscow). pp 130-3 of Fizicheskaya Priroda Plasticheskoi Deformatsii i Razrusheniya Metallov. Svechnikov, V. N. (ed.). Kiev; Naukova Dumka (1969). (In Russian).

A specially constructed apparatus was used to study the deformation, quenching, and cooling (with and without magnetic fields) of wire specimens of 99.99% Ni and of Fe-Gd alloys containing 0.2 or 0.5% Gd. The coercive force, H_c, of Ni after loading and quenching from 800, 850, and 900°C increased almost linearly with increase in loading from 2.0 to 4.5 kg. On quenching Ni from 800°C, H_c increased by 9 times after 5% deformation. The increase in H_c was inhibited when a magnetic field was applied during quenching: this is explained by the effect of magnetostriction stresses and, in this case, the elongation is reduced. The Fe-Gd alloys were quenched from 1000°C and loaded to 4.5 kg. For these alloys the increase in H_c was ~30% and a magnetic field had no effect, evidently because of the lower magnetostriction of Fe. (Referativnyi Zh.)

16470 INFLUENCE OF THE COMPOSITION OF Fe-Co-W ALLOYS ON THE TENDENCY TO CRACKING DURING WEAR-RESISTANT SURFACING. Demyantsevich, V. P.; Khutoryanskii, E. D. Tr. Leningrad. Politekh. Inst.; No. 308, 191-7 (1970). (In Russian).

The limits of Co and W content in dispersion-hardened Fe-Co-W alloys were determined for use of these alloys in production of welds without fissures. One such alloy crystallizes by formation of an alpha phase containing about 14.5% Co and about 30% W. A second alloy crystallizes by formation of alpha plus gamma phase; the alpha phase containing Co in the range 14.5 to 19% Co and 20 to 30% W, and the gamma phase containing 14.5 to 17% Co and W content up to 20%. A third alloy crystallizes by peritectic transformation in which one phase contains 12 to 14% Co and 40 to 45% W and the other contains 14.5 to 20% Co and 30 to 32% W. No Co-Fe-W alloys except these were found which can be used to produce fissure-free welds. (tr-auth)

16471 METODY ISSLEDOVANIYA SVOISTV METALLICHESKIKH RASPLAVOV. (Methods of Investigating the Properties of Molten Metals). Vertman, A. A.; Samarin, A. M. Moscow; Izdatel'stvo Nauka (1969). 200p.

Problems of measuring viscosity, density, electric properties, magnetic properties, and mass transfer interphase energy of metallic melts are examined. Methods for high-temperature centrifugation are described. Each chapter of the book contains a word definition section. The book is useful as a reference; a large bibliography is included. The information presented is based on research results, results obtained in industrial laboratories, and on graduate theses. (J.R.D.)

16472 COMPARATIVE INVESTIGATION OF INTERACTION OF TUNGSTEN DIOXIDE AND MOLECULAR OXYGEN WITH TUNGSTEN SURFACES. Karmanov, G. A.; Ptushinskii, Yu. G.; Chuikov, B. A. (Inst. of Physics, Kiev). Ukr. Fiz. Zh.; 15: 1041-4(Jun 1970). (In Russian).

A comparative study of the interaction of O_2 or WO_2 with tungsten surfaces was conducted using a flash method in the regime of single counting of desorbed particles. It was found that the mass spectrum of thermodesorbed products on the monomolecular layers does not depend on the state that acts on the surface (O_2 or WO_2). This fact was used to estimate the distribution of O_2 between the atomic and oxide phases of desorption. (tr-auth)

16473 IMPROVEMENTS IN JOINTS BETWEEN STEEL ELEMENTS AND ZIRCONIUM-BASED ELEMENTS. (to Ugine Kuhlmann). British Patent 1,220,638. 27 Jan 1971. Priority date 17 Nov 1967, France.

A process is described for protecting metallic joints, one member of which is Zr or Zr-base alloy and the other is steel, against hydrogen embrittlement. The joint is dip-coated in a bath at 575 to 800°C containing an Al-base alloy composed of 1 to 13 wt % Si, 0.2 to 5% Zr, 0.2 to 10% Fe, and one of the alloying elements of the steel and/or the Zr alloy in the proportion 0.2 to 15% each. (J.R.D.)

16474 EFFECT OF THE MELTING CONDITIONS WITH AN ELECTRON BEAM ON THE PROPERTIES OF TUNGSTEN. Efimov, V. E.; Zaboronok, G. F.; Kozlov, A. T.; Zabavnova, A. P. Tsvetn. Metal.; No. 7, 59-61(Jul 1970). (In Russian).

Experiments were carried out to study the effect of melting conditions, especially of the melting rate, and of deoxidizers, such as zirconium and titanium, on the properties of unalloyed tungsten. The metal was evaluated on the basis of the mechanical properties of the recrystallized specimens. The 70-mm diameter ingots were prepared from tungsten rods in an electron beam smelting furnace. The grain size of the metal was 5 to 8 mm and its Brinell hardness was about 340 kg/mm^2. The ingots were pressed, recrystallized in hydrogen, pressed again and annealed. The annealed specimens exhibited fewer defects. The recrystallization temperature was determined on the basis of hardness measurements and by the study of the structure. The recrystallization was completed at 1400°C; at 1200°C it could not be observed at all. The cold brittleness threshold of recrystallized tungsten was found to lie below 500°C, as compared with the 550 to 600°C range for the metal prepared by vacuum arc furnace melting. (TTT)

16475 NIOBIUM-BASED ALLOYS FOR ELASTIC SENSORS. Eliseev, S. A.; Shpitsberg, A. L.; Ryabysheva, N. D.; Kalachev, I. B.; Savinov, A. T. Tsvetn. Metal.; No. 7, 61-2(Jul 1970). (In Russian).

Use of refractory metals as alloying components helps to extend the field of applicability of elastic sensors beyond the current limit of about 550°C. Niobium-base alloys containing molybdenum, zirconium, and in one case also titanium and chromium, were prepared by melting the ingots in a vacuum electric-arc furnace. Study of the phase composition revealed the existence of simple and complex niobium carbides in addition to the homogeneous solid solution. The alloy containing 3.7% Mo, 2.3% Zr, 1.9% Ti, 0.03% C, 0.02% N + O, the rest being Nb, was further treated to develop an elastic sensor with high relaxation stability at an operating temperature of 700 to 750°C. The study revealed that niobium-based alloys may be conveniently strengthened by heat treatment in vacuum, involving quenching from the 1400 to 1880°C range and aging at 950 to 1050°C; the treatment provides the alloys with mechanical properties required to operate at temperatures up to 800°C as elastic sensors. (TTT)

16476 CALCULATION OF X-RAY ELASTIC CONSTANTS FROM SINGLE CRYSTAL COEFFICIENTS OF HEXAGONALLY CRYSTALLIZING METALS. Evenschor, P. D.; Froehlich, W.; Hauk, Viktor (Technische Hochschule, Aachen). Z. Metallk.; 62: 38-42(Jan 1971). (In German).

The x-ray elastic constants of hexagonally crystallizing metals were computed from the single crystal coefficients according to the limiting averaging procedures according to W. Voigt (homogeneous strain) and according to A. Reub (homogeneous stress). The values were computed for 11 metals and were plotted as a function of orientation. (auth)

16477 COMPOSITION AND CAST STRUCTURE EFFECTS ON SUPERALLOY PROPERTIES. Ordillas, Meliton Umipig Jr.

Cleveland; Case Western Reserve Univ. (1970). 118p. University Microfilms Order No. 70-25,904.

Thesis.

Various types of congruently melting phases were selected and tested to determine their properties and feasibility for casting. The better congruently melting alloys were modified with a considerable number of additions to enhance oxidation resistance, provide solid solution strengthening, and produce discrete precipitates from the melt. The resulting modified alloys had a complex structure. Stress rupture testing was employed to screen these alloys and promising high temperature properties were obtained with the Fe–50 Co and Co–15 W alloys. The microprobe was employed to determine the effects of the various elements on the structure of the Fe–50 Co and Co–15 W base alloys, while metallographic examination of stress rupture test bars was employed to determine the phases associated with failure during testing. Based on these examinations, elements responsible for embrittling phases, those that had little effect or duplicated the influence of more desirable elements were removed. Although chromium did not provide carbide strengthening, it was a potent solid solution strengthener and was increased. This composition modification process was effective in changing the microstructures of the alloys to the desired ones where small discrete precipitates were randomly distributed in the matrix. The stress rupture properties of the Fe–50 Co base alloy were not greatly affected but the behavior of the Co–15 W base alloy was markedly improved. A faster solidification rate and partial directional solidification obtained with a chill at the bottom of the heated mold increased the stress rupture properties of both alloys. Lower mold temperatures plus chilling of the test bar produced a finer structure and some further improvement in properties. The Co–15 W–20 Cr–2 Zr–2 Ti–1 C alloy developed in this study, when cast with a chill at the base of the casting, exhibited stress rupture behavior comparable to the better Ni-base superalloys. (Diss. Abstr. Int., B)

16478 EFFECTS OF INTERSTITIAL IMPURITIES ON MECHANICAL PROPERTIES OF BCC METALS. Smialek, Robert Louis. Cleveland; Case Western Reserve Univ. (1970). 188p. University Microfilms Order No. 70-25,919.

Thesis.

The strong temperature dependence of the flow stress of bcc metals at temperatures below ~0.1 T_m was generally attributed to either the inherent lattice friction of the bcc structure (the Peierls stress) or to interstitial solution hardening from residual impurities. In an attempt to determine which process is rate-controlling at low temperatures, very high purity (with regard to interstitials) tantalum single crystals were prepared. The purification treatment greatly reduced the temperature dependence of the flow stress, as well as slightly reducing the athermal component of the yield stress of Ta which was given 6 zone refining passes only. Small, controlled additions of interstitial O, N, and C (10 to 1000 at. ppM) were introduced into the pure Ta. The yield and flow stresses were found to increase rapidly with interstitial content over the temperature (4.2 to 550°K) and composition ranges investigated. In addition, the rate of solution hardening was found to be a strong function of temperature in the low temperature region. Strain-rate cycling experiments were performed on the Ta–N alloys; results indicated that interstitials were important in the deformation process but were not rate-controlling. A model involving double kink nucleation on screw dislocation segments of finite length is proposed to explain the experimental observations. Additional experiments were performed on purified vanadium single crystals and on purified tantalum–rhenium alloy crystals. Three-stage hardening was observed for the first time in vanadium single crystals. The anomalous solution softening effect previously observed in the Ta–Re system was found to be a result of interactions of Re with the residual nitrogen impurities usually present in such alloys. (Diss. Abstr. Int., B)

16479 COMMENTS ON THE CONDITION OF BORON IN α-IRON. Lucci, A.; Venturello, G. (Univ., Turin). Scr. Met.; 5: 17-24(Jan 1971).

Comments are given on a paper published previously concerning the condition of boron in α-iron. The paper was abstracted in NSA as 24: 32442. (G.M.C.)

16480 REPLY TO THE "COMMENTS ON THE CONDITION OF BORON IN α-IRON." Hayashi, Y.; Sugeno, T. (Tokyo Univ.). Scr. Met.; 5: 25-6(Jan 1971).

A rebuttal is given to Lucci and Venturello [Scr. Met., 5: 17-24 (1971)] concerning their comments on a paper dealing with the condition of boron in α-iron (previously published and abstracted in NSA as 24: 32442). (G.M.C.)

16481 THE RELAXATION STRENGTH (Δ/At.% SOLUTE) FOR OXYGEN IN VANADIUM. Hasson, D. F.; Arsenault, R. J. (Univ. of Maryland, College Park). Scr. Met.; 5: 75-9(Jan 1971).

The relaxation strength for oxygen in vanadium was determined from the results of internal friction tests on annealed and oxidized vanadium samples. The results were critically compared with those of Powers and Doyle. The tetragonal strain parameter was also calculated. (G.M.C.)

16482 STRENGTH OF NIOBIUM–OXYGEN SOLID SOLUTIONS. Ravi, Kramadhati V. Cleveland; Case Western Reserve Univ. (1969). 340p. University Microfilms Order No. 70-25,992.

Thesis.

The effects of small and controlled additions of oxygen to high purity niobium single crystals oriented for single glide were studied by a combination of mechanical testing in tension and compression, internal friction and transmission electron microscopy. At 298°K and above the addition of oxygen increased the critical resolved shear stress in a nonlinear manner. At low temperatures down to 77°K the shear stress decreased with initial alloying and passed through a minimum before increasing again with composition at higher oxygen concentrations. This phenomenon of alloy softening was accompanied by corresponding changes in the activation parameters such as activation volume, activation energy, and the dislocation velocity stress exponent. The fracture characteristics, the work hardening behavior, and the dislocation substructure were also found to change with alloy softening and alloy hardening. Aging the Nb–O solid solutions at various temperatures enhanced the degree and extent of alloy softening without affecting the internal friction behavior of the alloys. The addition of hydrogen to niobium was found to increase the temperature dependent portion of the shear stress, no alloy softening being observed in the Nb–H alloys. The low temperature strength of high purity niobium is shown to be due to dislocation-interstitial interaction and not due to the intrinsic strength of the metal. None of the solid solution hardening theories were found to be applicable to the Nb–O system over the entire composition range investigated. Alloy softening in bcc metals is postulated to be due to a non-random distribution of solute atoms. A model is proposed wherein interstitial association in solution in niobium causes alloy softening. Alloy softening arises as a result of solute association which modifies the solute properties by decreasing the total number of thermally activable barriers to dislocation motion, changing the strain fields associated with the individual interstitials, and modifying the temperature dependent contribution to strengthening of the individual interstitial. (Diss. Abstr. Int., B)

16483 THE EFFECTS OF SMALL ADDITIONS OF NITROGEN AND ALLOYING ELEMENTS ON THE MECHANICAL PROPERTIES OF LOW ALLOY HIGH STRENGTH WELD METAL. Machmeier, Paul Martin. Bethlehem, Pa.; Lehigh Univ. (1970). 112p. University Microfilms Order No. 70-26,158.

Thesis.

The mechanical properties resulting from the influence of small quantities of alloying additions on 3Ni–Mn–Mo and 5Ni–Cr–Mo weld metals deposited primarily by the GTA and GMA weld processes were studied by standard Charpy V-notch and tensile tests. Analysis of the reference welds revealed that the 3Ni–Mn–Mo alloy had the most favorable notch toughness properties while the 5Ni–Cr–Mo alloy possessed the best strength levels. In general, progressive additions of nitrogen and strong nitride formers singly or with nitrogen to the GTA and GMA 3Ni–Mn–Mo weld resulted in a general decrease in notch toughness with an accompanying gain in strength. Investigation of comparative effects of high nitrogen levels (240 to 280 ppM) on GTA deposited 3Ni–Mn–Mo and 5Ni–Cr–Mo weld metals showed similar behavior, since the 50 ft-lb transition temperature was increased 85 and 90° respectively. However, nitride formers, i.e., (Al, V) added to the GTA 5Ni–Cr–Mo alloy at similar nitrogen levels increased the 50 ft-lb transition temperature 180 and 160°F. This decrease in toughness attributed to a pronounced cellular solidification mode. The GMA 5Ni–Cr–Mo alloy system proved to be particularly susceptible to intergranular fracture at high nitrogen levels. Specifically an addition of 250 ppM nitrogen to GMA 5Ni–Cr–Mo weld metal raised the 50 ft-lb transition temperature 225°F. In the majority of alloys where the mechanical property changes were consistent with the level of elemental additions, the magnitude of notch toughness decreases can be accounted for by the structural refinement, fracture mode, and nitrogen compound formation. (Diss. Abstr. Int., B)

16484 URANIUM HARDENED BY BERYLLIUM OXIDE PARTICLES. Voloshchuk, A. I.; Gaidamachenko, G. S.; Golovchenko, Yu. M.; (and others). At. Energ. (USSR); 29: 178-83 (Sep 1970). (In Russian).

The properties of uranium hardened by beryllium oxide particles were studied. The material had a considerable creep strength at temperatures of 500 to 600°C. The experimental results indicated that the material had a high radiation stability under cavita-

XUM

tion swelling. The results of preliminary radiation tests on dispersion uranium are given. (auth)

16485 INVESTIGATION OF THE EFFECTS OF ROLLING ON THE STRENGTH OF NIOBIUM–COPPER ALLOYS. Aleksandrov, A. A.; Rybal'chenko, N. D.; Tron, A. C. Tr. Leningrad. Politekh. Inst.; No. 308, 107-10(1969). (In Russian).

Results of investigation related to preparation of Cu-base and Nb-base Cu–Nb alloys by vacuum rolling are presented. Initially heated Cu and Nb are vacuum fusible, however, the phase diagram of these metals shows that the solubility of Nb in Cu is very small. The peritectic transformation occurs in Cu at 10°C above its melting point. Since the heating and rolling of the Cu–Nb alloy was done at 1000°C, no significant transformation occurred in the boundary sections of the diffusion layers. (tr-auth)

16486 ULTRAFINE-GRAIN METALS. Proceedings of the 16th Sagamore Army Materials Research Conference Held at Raquette Lake, New York, August 19–22, 1969. Burke, John J.; Weiss, Volker (eds.). Sagamore Army Materials Research Conference Proceedings. Syracuse, N. Y.; Syracuse University Press (1970). 440p. $19.00. (CONF-690832).

Seventeen papers were presented at the conference. A separate abstract was prepared for each of four papers. Papers for which no abstracts were prepared are concerned with strength of ultrafine grain metals, preparation of ultrafine grain metals and alloys, properties of ultrafine grain materials, and uses of these materials. (J.R.D.)

For abstracts of individual papers see: 16487–16490.

16487 DUCTILITY OF ULTRAFINE-GRAIN ALLOYS. Morrison, W. B.; Miller, R. L. (United States Steel Corp., Monroeville, Pa.). pp 183-211 of Ultrafine-Grain Metals. /Burke, John J. (ed.). Syracuse, N. Y.; Syracuse Univ. Press (1970).

From 16th Sagamore Conference on Ultrafine Grain Metals, Raquette Lake, N. Y. See CONF-690832.

A study was made of the ductility of ultrafine-grain ($d < 10\ \mu m$) alloys as indicated by elongation and reduction in area measurements obtained from tension tests. The uniform elongation of an ultrafine-grain alloy is very small, particularly at high temperatures, and it continues to decrease as grain size decreases. The reduction in area values are generally large over a wide temperature range, and these increase as grain size decreases, although the effect is small. The total elongation of an ultrafine-grain specimen, made up of uniform elongation and the elongation resulting from necking, in general, is less than that of a coarse grained specimen. Some ultrafine-grain alloys in which Lüder's bands form may exhibit unstable plastic flow immediately after yielding, especially at low temperatures and high strain rates. As a consequence of the limited amount of plastic deformation, the total elongations in such instances are very small. At temperatures above about 0.5 T_M the total elongations of ultrafine-grain alloys are very large, which can be directly attributed to the high strain-rate sensitivity of the flow stress. (auth)

16488 WORK-HARDENING MODEL FOR THE EFFECT OF GRAIN SIZE ON THE FLOW STRESS OF METALS. Conrad, H. (Univ. of Kentucky, Lexington). pp 213-29 of Ultrafine-Grain Metals. /Burke, John J. (ed.). Syracuse, N. Y.; Syracuse Univ. Press (1970).

From 16th Sagamore Conference on Ultrafine Grain Metals, Raquette Lake, N. Y. See CONF-690832.

Experimental results as well as data in the literature on the effect of grain size on the flow stress of metals and on the dislocation density as a function of stress and strain are evaluated. It is shown that the data are in good accord with the work-hardening model for the effect of grain size on the flow stress proposed earlier. The model is supported by findings such as linear flow stress increase with the square root of the dislocation density independent of grain size. It was also found that the constants τ_i and α obtained from the intercepts and slopes of plots of the flow stress versus square root of dislocation density are in accord with those expected based on this model, and the values of the Hall-Petch parameters σ_i and K calculated from dislocation density measurements are in accord with those derived from Hall-Petch plots. (auth)

16489 THEORY OF DIFFUSIONAL FLOW WITH APPARENT NON-NEWTONIAN VISCOSITY IN FINE-GRAIN MATERIALS. Karim, A. (Massachusetts Inst. of Tech., Cambridge). pp 295-322 of Ultrafine-Grain Metals. /Burke, John J. (ed.). Syracuse, N. Y.; Syracuse Univ. Press (1970).

From 16th Sagamore Conference on Ultrafine Grain Metals, Raquette Lake, N. Y. See CONF-690832.

Diffusional flow under stress-directed diffusion of vacancies, either through the lattice as proposed by Nabarro and Herring or through the grain boundaries as suggested by Coble and by Dorn and Mote, is Newtonian-viscous. However, experimental observations, with some magnesium-based alloys indicate a Bingham-type behavior: $\dot{\epsilon} = (\sigma - \sigma_0/\eta)$ where $\dot{\epsilon}$ is the diffusional flow rate, σ the applied stress, σ_0 the initial flow stress, and η the coefficient of viscosity. This makes the diffusional flow non-Newtonian in character, and its special significance during superplastic deformation is presented. Most of the experimental data available in the literature both for metals and ceramic materials which were reported to show pure diffusional creep behavior seem to obey, in principle, the equation. (auth)

16490 CURRENT STATUS OF APPLIED SUPERPLASTICITY. Headley, T. J.; Kalish, D.; Underwood, E. E. (Lockheed-Georgia Co., Marietta). pp 325-53 of Ultrafine-Grain Metals. /Burke, John J. (ed.). Syracuse, N. Y.; Syracuse Univ. Press (1970).

From 16th Sagamore Conference on Ultrafine Grain Metals, Raquette Lake, N. Y. See CONF-690832.

An ultrafine-grain size is the most important microstructural attribute of superplastic alloys. The current evidence bearing on the contributions of very small grains and very large grain boundary surface areas to the superplastic process is reviewed from a practical point of view. After discussing superplastic alloys that are commercially available, metal forming techniques that can utilize superplasticity are described. The known industrial applications of superplasticity are discussed. (auth)

16491 DIFFUSIVITY OF ZINC IN A Mg–5.1 PERCENT Zn–0.6 PERCENT Zr ALLOY. Bhambri, A. K.; Kattamis, T. Z. (Univ. of Connecticut, Storrs). Scr. Met.; 5: 53-8(Jan 1971).

The diffusivity of Zn in a Mg–5.1% Zn–0.6% Zr alloy at 310°C was calculated from previously determined solution kinetics data. A spherical diffusion model was adopted on the basis of the spherical distribution of zinc inside the alloy grain. (G.M.C.)

16492 STRENGTH-DIFFERENTIAL PHENOMENON IN ZIRCALOY-2. Mannan, S. L.; Rodriguez, P. (Bhabha Atomic Research Centre, Bombay). Scr. Met.; 5: 71-4(Jan 1971).

Experimental results showed that Zircaloy-2 exhibited the strength-differential effect, S–D, the phenomenon in which the yield strength of a material was greater in uniaxial compression than under uniaxial tension. The S–D effect was as high as 7.1 kg/mm^2 at zero plastic strain and reduced to 4.6 kg/mm^2 for 0.2% plastic strain. The tension and compression curves appeared to have a tendency to merge at higher strains. (G.M.C)

16493 FABRICATING THE REFRACTORY METALS. PART I. THE MATERIALS AND THEIR PROPERTIES. Mash, Donald R.; Bauer, Dieter W.; Schussler, M. (Fansteel Inc., Baltimore). Metal Progr.; 99: No. 2, 89-94(Feb 1971).

Properties and uses of refractory metals and alloys in the production of aerospace components, process equipment, and electronic parts are discussed. Refractory metals and alloys were selected primarily on their fabricability rather than their strength or corrosion resistance. Tantalum and niobium behaved well metallurgically and were preferred over tungsten and molybdenum by industry. The typical compositions, mechanical and physical properties of 17 commercial refractory metals and alloys are itemized. Industrial practices for production of refractory metals and alloys are described. (G.M.C.)

16494 SHOCK-COMPRESSION BEHAVIOR OF TANTALUM AT 25° AND 900°C. Rohde, R. W.; Towne, T. L. (Sandia Labs., Albuquerque, N. Mex.). J. Appl. Phys.; 42: 878-80(Feb 1971).

Experiments were conducted on 99.9% pure Ta to determine the accuracy of the Mie–Grueneisen constitutive relation for predicting off-Hugoniot states at moderate stresses. Hugoniot relationships were determined at 25 and 900°C; the Hugoniot elastic limit was relatively independent of temperature, being 17.5 and 15 kbar at 25 and 900°C respectively. The Grueneisen parameter $\gamma = 1.21$ is in fair agreement with that calculated from zero-pressure thermodynamic data. This behavior is contrasted with that observed for tungsten. (D.L.C.)

16495 OBSERVATIONS ON THE POST-IRRADIATION DUCTILITY OF A 15 PERCENT Cr, 15 PERCENT Ni, Ti, B STEEL FOR CLADDING AND OTHER CORE COMPONENTS. Lindhagen, P.; Oestberg, G. (Aktiebolaget Atomenergi, Studsvik, Sweden). Atomwirt., Atomtech.; 16: 82-3(Feb 1971).

The present studies of the effect of irradiation on the tensile and creep properties of 12R72HV are far from complete, in particular with regard to the importance of the pre-irradiation treatment.

However, effects of irradiation on the precipitation of carbide, not foreseeable from the behavior out-of-pile, seemed to have an important influence on the ductility of solution treated steel in addition to the role played by helium. It was found that 850°C annealed 12R72HV was less sensitive to irradiation enhanced precipitation. A comparison of data for other steels such as 304 Ti and 18/27 Al, Ti with those for 12R72HV, obtained under almost identical irradiation conditions, showed that as far as creep ductility is concerned the preference is for 304 Ti and 18/27 Al, Ti. (auth)

16496 ZIRCONIUM–NIOBIUM ALLOY FOR REACTOR USE. Kimura, Keizo (National Research Inst. for Metals, Tokyo). Chitaniumu Jirukoniumu; 18: No. 3, 55-60(Mar 1970). (In Japanese).

In order to construct the advanced converters of heavy water-moderated, light water-cooled type, pressure tubes are needed, whose thermal neutron absorption is small, high-temperature strength is high, and which are superior in corrosion resistance. Zr-2.5 Nb alloy was developed with the purpose of using it for pressure tubes. It is stronger than Zircaloy-2 or Zircaloy-4, and is superior in stability when it is irradiated with neutrons. The zirconium–niobium alloys for reactor use are described briefly. First, the properties required for pressure tube material, such as nuclear characteristics, strength, corrosion resistance, stability, anti-cracking property, abrasion resistance, and fabrication are explained. Secondly, Zr–2.5 Nb alloy, its heat treatment, mechanical properties, and cold working are described in some detail. (Japan)

16497 SPUTTERING YIELDS OF GOLD AND TANTALUM IN ARGON–OXYGEN MIXTURES. Harvey, J.; Corkhill, J. (Royal Aircraft Establishment, Farnborough, Eng.). Thin Solid Films; 6: 277-87(Oct 1970).

The sputtering yields of gold and tantalum in argon–oxygen mixtures were investigated in the oxygen partial pressure range 0 to 3×10^{-4} torr. The sputtering yield of gold was found to be substantially independent of oxygen partial pressure, while that of tantalum fell by a factor of about 6 to 8 as the oxygen pressure was increased. (auth)

16498 ZIRCONIUM ALLOYS IN NUCLEAR TECHNOLOGY. Scaroni, A. (CISE, Milan). Energ. Nucl. (Milan); 18: 19-32(Jan 1971). (In Italian).

The main properties of zirconium alloys are discussed with particular reference to Zircaloy and Zr–2.5% Nb alloy. The behavior of such alloys is considered mainly in connection with their use as fuel claddings and pressure tubes in water-cooled reactors, with respect to corrosion and to the effects of radiations and hydrogen absorption on short- and long-term mechanical properties. Some data are presented relevant to manufacturing and subsequent treatments before use in reactor. The present situation of other zirconium alloys is briefly examined, specially of those developed for operation at temperatures higher than those typical of the actual water-cooled reactors. (auth)

16499 EFFECTS OF HIGH TEMPERATURE SODIUM EXPOSURE ON THE TENSILE PROPERTIES OF SOME VANADIUM ALLOYS. Whitlow, G. A. (Westinghouse Electric Corp., Madison, Pa.). Contract AT(30-1)-3791. J. Nucl. Mater.; 38: 230-3(Feb 1971).

Some tensile data obtained from vanadium alloy samples exposed in redesigned sodium loop systems are reported. These samples did not exhibit any marked deterioration in post-exposure properties. (auth)

16500 IMPURITY DIFFUSION IN ISOTOPIC ^{6}Li AND ^{7}Li METAL. Ott, A.; Lodding, A. (Chalmers Univ. of Tech., Goteborg). Z. Naturforsch.; 25a: 1765(Nov 1970).

The mobilities of foreign metal tracers in isotopically pure lithium matrices have been studied. Differential diffusivities have been obtained for Na, Ag, Au, Zn, and Ga in Li. The behavior of impurities whose diffusion is not of a regular vacancy character (Au, Ag, Zn) appears connected with the quantum effects in Li self-diffusion. (auth)

16501 MEASUREMENT OF THE TOTAL EMISSIVITY OF AUSTENITIC STEELS. Krinninger, H. Waerme Stoffuebertrag.; 3: 139-45(1970). (In German).

For the calculation of heat transfer between reactor tank and double tank wall as well as for the calculation of temperature distribution in the SNR fuel element, in case of an assumed necessity of emergency cooling of a fuel element with regard to a clamping in the fuel handling machine, it is necessary to know the emissivity of the austenitic steels. Measuring method, test setup, geometry, and surface-conditions of the samples, protective gas impurity and method of test are described. The emissivity of the austenitic steels 1.4948 (X 6 CrNi 1811) and 1.4961 (X 8 CrNiNb 1613) for different surface treatments is given within the temperature range from 200 to 700°C. (auth) (INIS)

16502 FRACTURE BEHAVIOR OF FLAWED ZIRCALOY-2 PRESSURE TUBES. James, L. A.; Ostrom, T. R. (Battelle Memorial Inst., Richland, Wash.). Nucl. Eng. Design; 14: 286-92(Nov 1970).

Fracture tests were conducted on two sizes of Zircaloy-2 pressure tubes. It was found that failures produced from a sharp fatigue crack occurred at considerably lower stress levels than those produced from machined flaws of the same length. The test results were applied to an empirical failure criterion and found to agree reasonably well with published values of fracture toughness. (auth)

16503 FOIL-WRAPPING TECHNIQUE TO PREVENT THE CONTAMINATION OF VANADIUM ANNEALED IN SILICA IN THE TEMPERATURE RANGE 1000^{0} TO 1250^{0}C. Abe, K.; Toma, K.; Yoshinaga, H.; Morozumi, S. (Tohoku Univ., Sendai). J. Less-Common Metals; 23: 213-16(Feb 1971).

When vanadium of 99.9% purity was vacuum-sealed in a silica tube and annealed for one hour at temperatures above 1000°C, a bare sample was vigorously contaminated, a sample wrapped in tantalum foil was slightly contaminated, and a sample wrapped in zirconium foil was actually purified. It has been reported that a foil might have a physical barrier effect if its chemical reactivity for gaseous elements was equal to or less than that of the specimen. In the present investigation, a distinct difference was observed between the wrapping effects of tantalum and zirconium foils, whose reactivities were, respectively, less than and greater than that of vanadium. It is, therefore, reasonable to assume that tantalum foil has mainly a physical barrier effect, while zirconium foil has, in addition, a chemical gettering effect which is manifested by the gettering of gaseous impurities vaporized from the vanadium and/or of impurities in the surface layer by the deposited zirconium. (auth)

16504 INFLUENCE OF NITROGEN AND OXYGEN ON THE YIELD STRESS OF VANADIUM. Elssner, G.; Hoerz, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals; 23: 237-40(Feb 1971).

The dependence of the lower yield stress of vanadium on the nitrogen content, as well as on the oxygen content, was investigated at temperatures between –60 and 27°C for gas concentrations up to 1 at. %. (auth)

16505 THERMAL BENDING OF PLATES WITH CIRCULAR HOLES. Hoffman, R. E.; Ariman, T. (Univ. of Notre Dame, Ind.). Nucl. Eng. Design; 14: 231-8(Nov 1970).

The thermoelastic problem of a simply supported rectangular thin elastic plate with a circular hole and subjected to heat flow is solved by the method of point matching. The heat flow consists of an arbitrary temperature variation across the thickness of the plate but with no variation over the plate surfaces. The solution is derived in form of an infinite series in terms of circular cylindrical coordinates. Deflection and moment curves for various ratios of the diameter of the hole to the size of the plate are presented for the case of Poisson's ratio $\nu = 0.3$. (auth)

16506 EFFECT OF ALLOYING ELEMENTS ON THE MECHANICAL PROPERTIES OF WELDS IN ALLOYS OF THE SYSTEM TITANIUM–ALUMINUM–CHROMIUM AND TITANIUM–ALUMINUM–CHROMIUM–MOLYBDENUM. Khorev, A. I. Svar. Proizv.; No. 8, 29-32(Aug 1970). (In Russian).

A study was made of alloys of the system Ti–Al–Cr and Ti–Al–Cr–Mo. It is shown that alloys prepared simultaneously with the beta-stabilizing elements chromium and molybdenum have better mechanical properties than those alloyed with chromium alone. The plasticity of welds of alloys as annealed at $(t_{\beta} - 50)$°C is maintained satisfactorily when alloyed up to 12% with chromium and with up to 6% chromium plus 10% molybdenum. The strengthening heat treatment quenching from $(t_{\beta} - 50)$°C plus aging at 450 to 550°C for 10 hours as a method of raising the strength may be applied to welds of alloys Ti–3Al–(0.6 to 1.8)Cr–(1 to 3)Mo. At the same time, similar mechanical tests were conducted on welds of VT15 beta-alloys based on the system Ti–Mo–Cr–Fe–Al and Ti–Mo–V–Cr–Al. The given formulation does not increase the plasticity of the welds as strengthened by heat treatment. The tests resulted in the premature brittle failure of the specimens. (JPRS)

16507 RESONANT CHARACTER OF THE CHANGE OF THE SURFACE SELF-DIFFUSION ENERGY OF TUNGSTEN IN STRONG

XUM

ELECTRIC FIELDS. Pautov, D. M.; Shepilov, M. P. (Leningrad State Univ.). JETP Lett. (USSR) (Engl. Transl.); 12: 271-3 (20 Oct 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 393-6 (20 Oct 1970).

Measurements were made of the energy Q_m of surface diffusion of W in the vicinities of the (011) and (001) faces of W in pulsed electric fields F. Bright "collars" were formed on a W emitter by sputtering and monitored with a field-emission microscope during the measurements. Plots of Q_m vs F show complicated behavior, with many maxima and minima, contrary to Drechsler's expectation. The plots are asymmetric with respect to the point F = 0. A possible explanation of the results is offered. (D.L.C.)

16508 SPECIFIC ELECTRIC RESISTANCE OF MOLTEN INDIUM–TIN ALLOYS. Tschirner, H.-U.; Wobst, M. (Technische Hochschule, Karl-Marx Stadt, Ger.). J. Less-Common Metals; 23: 153-8(Feb 1971). (In German).

The electrical resistivity and its temperature coefficient of 41 liquid alloys of indium with tin were measured by means of an electrodeless rotating field method as a function of temperature. The measured resistivity isotherm at 300°C was compared with a calculation from the substitution-model given by Faber and Ziman. The curve of the temperature coefficient, plotted against the concentration, showed anomalies at concentrations of ~30 at. % Sn and ~90 at. % Sn. The agreement between the measured and the calculated resistivity isotherms was better at the indium-rich concentrations than at the tin-rich concentrations. (auth)

16509 SPECIFIC ELECTRIC RESISTANCE OF MOLTEN INDIUM–BISMUTH ALLOYS AND SOME OBSERVATIONS RELATIVE TO THE ARRANGEMENT OF THE SYSTEMS INDIUM–BISMUTH, INDIUM–TIN, AND BISMUTH–TIN IN THE SAUERWALD SCHEME. Tschirner, H.-U.; Wobst, M. (Technische Hochschule, Karl-Marx Stadt, Ger.). J. Less-Common Metals; 23: 203-11 (Feb 1971). (In German).

The specific electrical resistivity of 35 alloys was measured by means of the rotating field method and the results compared with theoretical and experimental values from the literature. On the basis of the results of this and previous investigations an attempt was made to assign the binary systems In–Bi, Bi–Sn, and In–Sn their appropriate place in the Sauerwald scheme. The resistance isothermal lines showed a slightly concave line (when plotted against the concentration axis), which agreed well with the calculated curve. The temperature coefficients showed reproducible anomalies at concentrations of 30 at. % and 50 at. % Bi. Whether they can be related to the solid compounds In_2Bi and InBi will depend on further work on the physical properties of this system. Whereas the binary systems In–Sn and Bi–Sn can safely be considered to belong to the solutions system of the Sauerwald system sufficiently significant contradictions are encountered in considering the results of the In–Bi system that it seems advisable to assign this system for the present to the intermediate systems. (auth)

16510 PRECIPITATION HARDENING IN VARIOUS ALLOYS. Technica (Basel); 19: 827-8(8 May 1970). (In German).

The conditions necessary for precipitation hardening are defined and reference is made to coherent and non-coherent precipitates. The effects of precipitation hardening on the mechanical properties of austenitic and non-austenitic steels, Al alloys, Be–Cu alloys, and Ni–Al alloys are described briefly. (Metals Abstr.)

16511 STUDIES ON CHILL CAST Al–Zr ALLOYS. II. EFFECTS OF Cu, Mg, Mn, Si, AND Zn ON AGE HARDENING OF CHILL CAST Al–1 PERCENT Zr ALLOY. Ichikawa, Riei; Ohashi, Teruo (Nagoya Inst. of Tech., Japan). Keikinzoku; 20: 435-42(Sep 1970). (In Japanese).

It was previously reported that supersaturated solid solutions containing up to 1.2% of zirconium in aluminum were obtained by quenching molten alloys and a remarkable hardening was found after aging the alloy at 400°C. The effects of the third additional elements such as copper, magnesium, manganese, silicon, and zinc on the age hardening of Al–1%Zr alloy are reported. The effects were investigated on wedge-shaped specimens obtained by rapid solidification. The supersaturated solid solutions containing Zr were found in the thinner part of the wedge-shaped specimens which were rapidly solidified. The range of thickness of specimens for forming such a structure depended upon the kind and quantity of the third additional elements. Remarkable age hardening was found in part of the supersaturated structure of the binary Al–1%Zr alloys by aging at 400°C for 1 hr. The effects of the third elements on the age hardening were arranged in ascending order as follows: Zn < Mg < Cu < Mn (in which the effect of Zn was nearly in the same order as the binary alloy containing no third elements). The alloy containing up to 2% Si showed remarkable age hardening, but when the Si content was more than 2%, the hardening decreased. (auth) (Japan)

16512 PRECIPITATION HARDENING IN THE Fe–W-, Fe–Nb, AND Fe–Ta SYSTEM ALLOYS. Takeyama, Muneyoshi; Hasegawa, Masayoshi; Okamoto, Masefumi; Tokoro, Kazunori (Waseda Univ., Tokyo). Tetsu To Hagane; 56: 1747-56(Nov 1970). (In Japanese).

Fe_2W, Fe_2Nb, and Fe_2Ta Laves phases ($MgZn_2$ type C14) were found in iron alloys containing 6.95 wt % W, 0.35 to 2.50 wt % Nb and 0.86 to 2.40 wt % Ta. The activation energy for the formation of this phase was estimated at about 51.0 kcal/mole in the Fe–W, 61.5 to 64.3 kcal/mole in the Fe–Nb and 60.0 to 60.4 kcal/mole in the Fe–Ta binary alloy by hardness measurements. An addition of niobium or tantalum to pure iron was effective for solution and precipitation hardening, and both elements showed the similar effects as solute at once. In the ternary alloys containing nickel, manganese, cobalt, silicon, and chromium, the precipitation process of Laves phase was similar to that in the binary alloy, on the other hand, in the Fe–W–Mn ternary alloy containing 5.6 wt % manganese the reversed austenite precipitated in Widmanstaetten wise in the ferritic matrix at aging temperature 650 to 850°C, and this austenite transformed to martensite by water-quenching from aging temperature. (auth) (Japan)

16513 ELECTROCHEMICAL BEHAVIOR OF MOLYBDENUM IN ACID CHLORIDE SOLUTIONS. Johnson, J. W.; Lee, M. S.; James, W. J. (Univ. of Missouri, Rolla). Corrosion; 26: 507-10(Nov 1970).

The anodic dissolution of Mo was studied in HCl–KCl solutions at 25°C. The apparent valences of Mo ions going into solution were approximately six. Slightly lower values were obtained in HCl solutions, the more pronounced changes occurring in the higher acid concentrations. The resultant ions in solution were Mo–VI. The Mo surface appeared to be covered with an oxide whose approximate composition was Mo_2O_5. The anodic dissolution was controlled by the oxidation of this oxide to MoO_3. (auth)

16514 DIFFUSION DATA. VOLUME 4, NUMBER 4, 1970. Woehlbier, F. H. (ed.). Diffus. Data; 4: 407-582(1970).

Data and information are presented on diffusion in metals and alloys, semiconductors, oxides, halides, and miscellaneous substances. (J.R.D.)

Structure and Phase Studies

Refer also to abstracts 17082, 17306, 17314, and 17319.

16515 (ORNL-tr-2440) ANNEALING OF METASTABLE ORTHORHOMBIC PHASES OF URANIUM–TITANIUM ALLOYS CONTAINING 4.8 AND 9.5 PERCENT TITANIUM. Bashwitz, R.; Colombie, M.; Foure, M. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from J. Nucl. Mater.; 28: 246-56(1968). 14p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 6703.

16516 (ORO-3908-2) STUDY OF THE STRUCTURE AND MECHANICAL PROPERTIES OF ORDERED ALLOYS. Technical Progress Report, January 1–December 15, 1970. LeFevre, B. G.; Starke, E. A. Jr. (Georgia Inst. of Tech., Atlanta. School of Chemical Engineering). Contract AT(40-1)-3908. 64p. Dep. NTIS.

The phenomenon of order strengthening has been studied in the systems Ni_4Mo and CuPt. The work on Ni_4Mo represents a continuation of earlier studies in which a correlation had been obtained between mechanical properties and the ordered microstructure. Transmission electron microscopy of deformed polycrystalline specimens and quantitative x-ray diffraction measurements on single crystals were used to determine the deformation mechanisms, the cause of intergranular failure, and the domain size and internal strains produced during ordering. It was found that ordered Ni_4Mo deforms by slip on $\{111\}_c$ planes by the motion of extended dislocations and that the root-mean-square strains determined by x-ray diffraction correlate directly with those calculated from yield strength measurements. A study of the relation between short range order and mechanical properties is also being conducted in this system, the progress on which is reported. In the system CuPt the results of microhardness measurements and optical metallography indicate that ordering strains are sufficient to produce "recrystallization" at the specimen surface and within the grain boundaries. (auth)

16517 (RFP–1535) REVERSIBLE MARTENSITIC TRANSFORMATIONS BETWEEN TRANSITION PHASES OF URANIUM-BASE NIOBIUM ALLOYS. Jackson, Ross J. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 23 Dec 1970. Contract AT(29-1)-1106. 11p. Dep. NTIS.

The occurrence and generation of transition phases in uranium–niobium alloys is discussed. The transition phases and unit cell parameters as a function of composition and temperature are presented. Also presented is an approximated transition phase diagram. The highly anisotropic lattice parameter changes of orthorhombic α', monoclinic α'', and tetragonal γ^0 with temperature and composition are discussed from a crystallographic viewpoint. Inherent in this discussion is the consecutiveness and thermal reversibility of the α', α'', and γ^0 structures; and the thermal reversibility of change in monoclinic cell angle of the α'' phase. (auth)

16518 (RLO–2225-T-13-6) A STUDY OF PHASE TRANSFORMATIONS AND SUPERCONDUCTIVITY. Annual Progress Report. Polonis, Douglas H. (Washington Univ., Seattle. Coll. of Engineering). 15 Oct 1970. Contract AT(45-1)-2225-T-13. 45p. Dep. NTIS.

Studies in the program have concentrated on the general problem of beta phase decomposition in alloys based on titanium and zirconium. Special emphasis has been placed on the effects of plastic deformation on the metastable beta phase and on the formation and reversion of the omega phase. The electron microscopy work on Ti–Cr alloys has not confirmed earlier reports that the omega phase can be formed in the metastable beta phase when it is subjected to plastic deformation during rolling. A martensitic phase is induced by such plastic strain, and there are indications that the formation of the omega phase during subsequent aging is inhibited by this deformation induced transformation. The electron microscopy studies have also revealed stacking faults in the beta phase and conclusive evidence for a phase separation reaction in binary alloys. Superconductivity measurements have proven to be very discriminating in the detection of minor perturbations in the structure and composition of beta stabilized alloys. It has been possible to detect phase separation processes and the initial stages of transformation to the omega phase before they are unambiguously discernible by any other available technique. An important development arising from these studies has been the establishment, by means of superconductivity measurements, that a phase separation reaction characterizes the decomposition of the metastable beta phase in several isomorphous and eutectoid-type alloy systems. The concurrent electron microscopy studies have confirmed the tendency for a phase separation reaction by revealing the presence of solute lean and solute rich regions in the beta phase of Ti–Cr alloys. By monitoring the transition from the normal to the superconducting state it has been possible to investigate the effects on omega phase precipitation of aging, step quenching, and reversion treatments. This work has shown that it is possible to exercise some control over the superconducting transition temperature by altering the alloy constitution and microstructure. The fact that the omega phase can be reverted by controlled heat treatments presents a new opportunity for the study of thermo mechanical processing and the development of high strength combined with acceptable ductility in Ti and Zr base alloys where the beta phase can be stabilized. (auth)

16519 MODEL FOR THE PREDICTION OF LATTICE PARAMETERS OF SOLID SOLUTIONS. Moreen, H. A. (Boeing Co., Seattle); Taggart, R.; Polonis, D. H. Met. Trans.; 2: 265-8 (Jan 1971).

A new model is presented which makes it possible to predict the lattice parameters of metallic solid solutions as a function of composition. This method is based on the hypothesis that the measured lattice parameter of a solid solution alloy is the average of all the inter-atomic spacings within a selected region of the lattice. (auth)

16520 SLIP AND TWINNING PROCESSES IN ZIRCONIUM. Dickson, John Ivan. Toronto; Univ. of Toronto (1969). National Library of Canada, Ottawa.

Thesis.

A room-temperature study of slip and twinning was performed employing new techniques for etching sub-boundaries and glide dislocations. Velocities of $\{10\bar{1}0\}\langle\bar{1}2\bar{1}0\rangle$ dislocations were measured at 295 and 373°K for oxygen contents between 100 to 400 ppM. The velocity results were compared to results obtained by indirect tests for determining dislocation mobilities. In addition to slip on $\{10\bar{1}0\}$ planes, slip on the (0002), $\{10\bar{1}1\}$ and $\{11\bar{2}2\}$ planes occurred at room temperature. Cross-slip between $\{10\bar{1}0\}$ and (0002) planes was also observed. Sub-boundaries were found to have a pronounced effect on dislocation motion, with the strength of polygonized sub-boundaries increasing with strain. The dislocation velocity obeyed the relationship, $v = B\,\tau^m$ where v is the velocity, τ is the applied shear stress and B and m are constants, characteristic of the crystal. The mobilities of edge and screw dislocations were similar at 373°K. At room temperature, screw dislocations were more mobile than the edge for the higher oxygen contents. These results suggest a change, between these two temperatures, in the rate-controlling mechanism for plastic deformation by prism slip. It is proposed that the change is in the nature of the interaction of the interstitial oxygen atoms with the dislocations. Twinning of $\{10\bar{1}2\}$, $\{11\bar{2}1\}$, and $\{11\bar{2}2\}$ planes occurred frequently. The nucleation of $\{10\bar{1}2\}$ microtwins involved a reaction between slip dislocations. Emissary dislocations were associated with some $\{10\bar{1}2\}$ and $\{11\bar{2}2\}$ twins. The emissary dislocations with large $\{10\bar{1}2\}$ twins appeared to be arranged in tilt boundaries. Some of the twinning results were more readily explained by assuming that the twin boundary consisted of a tilt boundary rather than a boundary containing pile-ups of partial dislocations. (auth)

16521 FIELD ION MICROSCOPY OF HAFNIUM. Reisner, Thomas; Nishikawa, O.; Mueller, E. W. (Pennsylvania State Univ., University Park). Surface Sci.; 20: 163-73(Mar 1970).

Field ion micrographs of hafnium with a satisfactory quality were obtained. Imaging conditions are described. Single and double leaved spirals around the $\{10\bar{1}0\}$, $\{10\bar{1}1\}$, and $\{20\bar{2}1\}$ planes were observed. The orbital model and the computed patterns of the hcp lattice are applied to explain the alternate dim and bright net plane layers of the $\{10\bar{1}0\}$ planes. The regional brightness distribution of hafnium is compared with Co, Re, and Ru and is discussed from the orbital model's point of view. (auth)

16522 FACETING AND SURFACE TRANSPORT PHENOMENA ON TUNGSTEN IN THE PRESENCE OF AN ELECTRIC FIELD OR A TEMPERATURE GRADIENT. Adam, P.; Wever, H. (Technische Univ., Berlin). Surface Sci.; 21: 307-23(Jul 1970).

Drawn tungsten wires of 100 μm dia. develop an orientation dependent characteristic steplike surface structure after prolonged dc anneals, while ac anneals yield no structure (dc effect). Annealing experiments had been performed with electron beam melted tungsten single crystals in order to explain the dc effect and to obtain results on electro- and thermo-transport on surfaces. The tungsten single crystals displayed thermal faceting in high vacuum and in a pure hydrogen atmosphere with (110) and (112) facet planes in both cases. The observed relationship between the transport force direction and the orientation of the facets in a hydrogen atmosphere has led to a model of faceting in the presence of a direct-current or a temperature gradient, pertaining to wires and single crystals. The influence of the "drag" of charge carriers has to be questioned. (auth)

16523 COMPARISON BETWEEN FIM AND LEED STUDIES OF SURFACE RECONSTRUCTION. Rendulic, Klaus D. (Pennsylvania State Univ., University Park). Surface Sci.; 21: 401-12 (Jul 1970).

Surface reconstruction of oxygen-covered tungsten is studied with the help of field ion microscopy. Superstructures are seen on the tungsten (100), (110), and (112) planes. Several areas of the hemispherical sample are found to develop facets of the (112) and (110) type. The observed structures are compared with those derived by other investigators using LEED. A discussion of the potential and limitations of field ion microscopy in the area of surface rearrangement is given. (auth)

16524 STRUCTURE AND LATTICE CONSTANTS IN Nb–V–Mo ALLOYS. Sirota, N. N.; Stribuk, E. K. (Inst. of Physics of Solids and Semiconductors, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk; No. 4, 128-9(1970). (In Russian).

Metallographic and x-ray analyses of 66 specimens of Nb–V–Mo alloys showed formation of continuous solid solutions along the whole systems. Concentration changes in the lattice constants are described by deviations from Vegard's additivity law in the direction of increased interatomic distances. (R.V.J.)

16525 DIFFUSION STUDY IN THE V–Ga AND Nb–Al SYSTEMS WITH THE ELECTRON-PROBE MICROANALYZER. Ronami, G. N.; Kuznetsova, S. M.; Kunakov, Ya. N.; Vorob'eva, N. S. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; No. 6, 101-3(Nov-Dec 1968). (In Russian).

Intermediate phases of superconducting systems of V–Ga were studied using specimens annealed at 450 to 1230°C. Data obtained revealed α solid solution, $\beta(V_3Ga)$-, $\delta(V_6Ga_5)$-, and $\epsilon(V_2Ga)$ phases. The presence of the ϵ phase in the layer obtained at 1200°C was not in agreement with published data. Diffusion layers of Nb–Al systems obtained at 1000 to 1650°C revealed the following phases: α-solid solution, β-phase(Nb_3Al), Nb_2Al, and $NbAl_3$. Solubility of Al and Nb increased with the increase of temperature and was

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5 wt % at 1650°C. The Nb_3Al phase existed in a wide range of concentrations (at 1400 and 1650°C with 6 wt %). The phase of $NbAl_3$ is strongly stoichiometric in the range of temperatures studied. (R.V.J.)

16526 CRYSTAL STRUCTURE OF $Nb_{12}Al_3Ge$. Ageev, N. V.; Alekseevskii, N. E.; Shamrai, V. F. Izv. Akad. Nauk SSSR, Metal.; No. 3, 171-6(May-Jun 1970). (In Russian).

Results of investigations showed that the ordered location of Nb atoms in $Nb_{12}Al_3Ge$ are relatively structurally equivalent positions to 6 (C) for the thermal regimes examined. The Ge and Al atoms are structurally equivalent to positions 2 (A) which are accompanied by the formation of crystal superstructure. Examinations of various configurations of superstructure confirm its formation. (tr-auth)

16527 PHASE DIAGRAM OF W–Re–Ir. Savitskii, E. M.; Tylkina, M. A.; Zhdanova, L. L. Izv. Akad. Nauk SSSR, Metal.; No. 3, 181-3(May-Jun 1970). (In Russian).

A phase diagram of W–Re–Ir alloys was prepared from data obtained by physiochemical methods emphasizing the W-rich portion. The approximate locations of all phase regions in this system are also shown. Technology of solid solutions in the system allows preparation of W–Re–Ir bars, ribbon, and sheets by hot forging, drawing, or rolling. (tr-auth)

16528 PHASE DIAGRAM OF Nb–Ti–Mo–V ALLOYS. Polyakova, R. S. Izv. Akad. Nauk SSSR, Metal.; No. 3, 199-204(May-Jun 1970). (In Russian).

Physical and chemical methods were used to study two cross sections in this system. It was found that alloys in the system are crystallized as continuous solid solutions with body-centered lattices. X-ray phase analyses and microstructural studies revealed that a large beta solid solution phase is apparent in the diagram which is conjugated with a two-phase volume of alpha plus beta which is in turn at the peak of the Ti phase and adjoins the narrow alpha solid solution phase. It was found that saturation of Nb by other components increases hardness. Hardness at 1000°C is characterized by light sections where the ratio of Ti to the sum of Mo plus V constitutes a ratio of 1 to 3 or 1 to 9. High electric resistance is found in alloys in which the relation of Ti to the sum of Mo plus V is 3 to 1. The alloys must be protectively coated for high temperature work. (tr-auth)

6529 MICROSTRUCTURAL EFFECTS OF HEAT TREATMENT ON THE BOND INTERFACE OF EXPLOSIVELY WELDED METALS. Trueb, Lucien F. (Univ. of Denver). Met. Trans.; 2: 145-53(Jan 1971).

The microstructure and composition of the interface of nickel-to-copper, copper-to-steel, and tantalum-to-steel explosion welds which were subjected to heat treatments between 500 and 1100°C were investigated by electron microscopy and electron probe microanalysis. The results confirmed that explosive welding established continuous and practically diffusionless metallurgical bonds. Diffusion induced by heat treatment caused characteristic microstructural changes along the bond zone which depended on the type of binary phase diagram to which the specimen belongs. The diffusion penetration in nickel explosively welded to copper was noticeably more extensive than in the similar electroplated couple. In all three metal pairs the diffusion rate varied cyclically along the weld interface. These latter effects appeared to be related to the unique concentration and distribution of lattice defects characterizing explosively bonded metals. (auth)

16530 STRUCTURES, FAULTS, AND THE ROD-PLATE TRANSITION IN EUTECTICS. Cline, H. E.; Walter, J. L.; Lifshin, E.; Russell, R. R. (General Electric Research and Development Center, Schenectady, N. Y.). Met. Trans.; 2: 189-94(Jan 1971).

The microstructures of several eutectic alloys were examined by scanning electron microscopy. Eutectic alloys of Ni-W, NiAl-Cr, NiAl-Cr (Mo) were directionally solidified and selectively etched to reveal the microstructure in three dimensions. A variety of rod and plate structures were observed that illustrated the rod-plate transition. In a nonfaceted rod eutectic, a fault structure consisting of branched rods and rod terminations was observed, while in a faceted alloy faults consisted of a web connecting two faceted rods. During solidification, the web structure split into two faceted rods producing a plate to rod transition. The formation of a web between two rods caused the transition from rods to plate. In Ni-W, the rod structure transformed to plates in grains where the growth direction deviated from being parallel to the facet planes. It was concluded that alignment is a principal factor in the rod plate transition. (auth)

16531 PHASE RELATIONS IN CONCENTRATED Ta–Hf AND Nb–Hf ALLOYS. Carpenter, R. W.; Liu, C. T.; Mardon, P. G. (Oak Ridge National Lab., Tenn.). Met. Trans.; 2: 125-31(Jan 1971).

The precipitation reactions occurring in concentrated Ta-Hf and Nb-Hf alloys over the temperature range 600 to 1400°C were investigated by x-ray diffraction and transmission microscopy. In Ta-Hf alloys containing 30 to 62 at. % Hf and Nb-Hf alloys containing 25 to 50 at. % Hf a stable bcc solid solution existed at elevated temperature. When quenched from the single phase region and aged at lower temperatures both alloys precipitated α phase, an hcp hafnium-rich phase. Transmission microscopy showed that in the Nb-Hf system the precipitation reaction began with the formation of coherent zones. Further aging caused coarsening into discs, still at least partially coherent. When coherency was lost the α morphology changed to rod-type. The effect of small amounts of oxygen added to these alloys during aging was an increase in the unit cell size of the α phase. Oxygen concentrations up to ~0.5 at. % did not cause observable changes in the phase relations. These results cannot be reconciled with the miscibility gap-monotectoid type phase diagrams reported by some earlier investigators and indicate that the proper phase diagram for both systems is the β-isomorphous type. (auth)

16532 SHORT RANGE ORDER IN Ni–Mo ALLOYS: STRUCTURAL CONSIDERATIONS. Okamoto, P. R.; Thomas, G. (Univ. of California, Berkeley). Mater. Res. Bull.; 6: 45-9 (Jan 1971).

The structural aspects of short range ordering, SRO, in the Ni-Mo system are discussed. Particular attention is paid to the relationship between the $1\frac{1}{2}$O SRO peaks and the occurrence of nonconservative antiphase boundaries within microdomains possessing either the Ni_4Mo or the Ni_2Mo superstructures. The initial stages of the transition from the SRO to the long range ordered states are believed to involve the transformation of nonconservative antiphase boundaries to the conservative type. (auth)

16533 GRAIN SIZE DEPENDENCY OF BETA-PLUTONIUM PLASTICITY. Allen, R. P.; Arrowsmith, H. W.; Nelson, R. D. (Battelle-Northwest, Richland, Wash.). Met. Trans.; 2: 344-6 (Jan 1971).

The superplasticity of β-Pu formed from α-Pu and the brittle behavior of β-Pu formed from γ-Pu were related to grain size. Deformation and x-ray metallographic studies confirmed the postulated difference in the grain size of $\beta\alpha$, formed from the lower temperature monoclinic α phase, and $\beta\gamma$, formed from the higher temperature face-centered orthorhombic γ phase. The results further showed that $\beta\alpha$ had the fine grain structure characteristic of superplastic materials. (G.M.C.)

16534 FIELD ION MICROSCOPE OBSERVATIONS OF AN INCOHERENT TWIN SEGMENT. French, R. D. (Army Materials and Mechanics Research Center, Watertown, Mass.). Met. Trans.; 2: 321-2(Jan 1971).

A field ion microscope investigation of Fe-W alloys produced a field evaporation sequence showing the gradual disappearance of a twin segment. Boundary movement permitted an analysis of the twin in terms of the crystallographic indices of its shear plane and plane of symmetry. The twin was shown to be incoherent by definition and to have nonplanar boundaries. Field ion micrographs of the twin and a stereogram tracing boundary movement during field evaporation are presented. (auth)

16535 GROWTH OF THE Ni–W EUTECTIC. Kurz, Wilfried; Lux, Benno (Battelle Memorial Inst., Geneva). Met. Trans.; 2: 329-31(Jan 1971).

During the solidification of a Ni-W eutectic alloy, a composite structure of 6 vol % W in a Ni-W solution was formed. The results of unidirectional solidification experiments showed that, at slow growth rates and with steep temperature gradients, a preferential growth of tungsten rods with round, rectangular, and hexagonal sections occurred. By increasing the growth rate, tungsten lamellae were formed. In the intermediate range of growth conditions, rods and lamellae were observed together. (auth)

16536 ELECTRON MICROPROBE STUDY OF THE CARBON CONTENT OF FERRITE AND BAINITE IN Fe–C–Mo AND Fe–C–Cr ALLOYS. Kinsman, K. R.; Eichen, E.; Aaronson, H. I. (Ford Motor Co., Dearborn, Mich.). Met. Trans.; 2: 346-8(Jan 1971).

The carbon content of ferrite and bainite (defined by kinetic and surface relief terms) in Fe–C–Mo and Fe–C–Cr alloys was determined by electron microprobe analysis. (G.M.C.)

16537 PHASE EQUILIBRIA IN THE U–UAl_2–Al_2Mo_3–Mo SYSTEM. Petzow, Guenter; Rexer, Juergen (Max-Planck-Institut

fuer Metallforschung, Stuttgart). Z. Metallk.; 62: 34-8(Jan 1971). (In German).

The equilibria in the U–UAl_2–Al_8Mo_3–Mo system were determined by microscopic, x-ray and thermal analyses. Results are presented in three isothermal sections at 1250, 1050, and 500°C and in seven temperature concentration sections. The transformation equilibria based upon the polymorphism of uranium are discussed and the reaction scheme is indicated. The system was characterized by extensive heterogeneous phase fields with the Laves phases UAl_2 and $U(Al,Mo)_2$ predominating. They caused the system to be subdivided into two partial sections similar to quasi-binary sections. The γ-U-Mo solid solution extends only slightly to ternary concentrations on addition of aluminum. (auth)

16538 STRUCTURE-FACTOR AND RESISTIVITY OF LIQUID INDIUM AT TEMPERATURES BETWEEN 165 AND 665°C. Ruppersberg, H.; Winterberg, K. H. (Univ., Saarlandes, Saarbruecken, Ger.). Phys. Lett.; 34A: 11-13(25 Jan 1971).

The structure-factor S(T,k) of liquid indium was determined by x-ray diffraction for temperatures between 165 and 665°C. With Ziman's theory, the electrical resistivity ρ is calculated. The results agree well with experimental values. (auth)

16539 GRAIN-BOUNDARY DISLOCATIONS IN TUNGSTEN WIRE. Loberg, B.; Norden, H. (Chalmers Tekniska Hoegskola, Goteborg). Ark. Fys.; 40: 413-19(1970).

The structure of high-angle grain boundaries in tungsten wire has been observed by electron and field-ion microscopy of the same specimens. A significant number of the boundaries contained boundary dislocations, which were found to have Burgers vectors differing from those normally encountered in an infinite bcc lattice. (auth) (Sweden)

16540 STRAIN INDUCED MARTENSITIC TRANSFORMATION IN ZIRCONIUM/3 wt % MOLYBDENUM/1 wt % ALUMINUM. Delvecchio, G. A.; Northwood, D. O.; Osborne, D. E.; Rezek, J. (Univ. of Windsor, Ont.). J. Nucl. Mater.; 38: 121-31(Feb 1971).

A study was made of certain morphological and crystallographic changes associated with the strain induced transformation of retained β to martensitic α′ in Zr/3 wt % Mo/1 wt % Al alloy. It was found that the c/a ratio for the hcp α′ phase increased with increasing transformation (deformation). On the basis of a decreasing α parameter of the α′ phase with increasing deformation it was deduced that the regions of the β phase that were deficient in the β stabilizer (Mo) transformed first of all to α′. Resistivity measurements and metallography showed that the transformation occurred at the early stages of deformation. The platelets of α′ nucleated at twin, deformation, and grain boundaries and propagated in definite crystallographic directions. Varying the deformation temperature produced a change in both the amount and the morphology of the transformation. An increase in hardness was noted during the course of the transformation which could provide the basis for a high-strength alloy. (auth)

16541 FISSION-PRODUCT INCLUSIONS IN IRRADIATED URANIUM–PLUTONIUM CARBIDE. Bramman, J. I.; Sharpe, R. M.; Dixon, R. (United Kingdom Atomic Energy Authority, Thurso, Scotland). J. Nucl. Mater.; 38: 226-9(Feb 1971).

Solid fission product inclusions in (U, Pu)C which was irradiated in the Dounreay Fast Reactor to a maximum burnup of 4 to 4.7% heavy atoms were studied. The inclusions were found to have an approximate composition of (U, Pu) (Pd, Rh, Ru)$_3$. (G.M.C.)

16542 STUDY OF THE PHASE DIAGRAM FOR THE YCd_3–Zn PSEUDO-BINARY SECTION OF THE YTTRIUM–CADMIUM–ZINC SYSTEM AND ON ITS COMPOUNDS. Hahn, B. H. J. Korean Inst. Metals; 7: 102-8(Sep 1969). (In Korean).

Phase boundaries for the Y–Cd_3–Zn pseudo-binary section of the Y–Cd–Zn system were studied by differential thermal analysis, metallographic, microprobe analysis, neutron activation analysis, and x-ray diffraction methods. A compound $(YCd_3)Zn_2$ was found which decomposed peritectically at 757°C. Compounds whose compositions were thought to be $Y_3Cd_4Zn_7$ and Y_2CdZn_{14} decomposed congruently at 840 and 875°C in the range 10 to 25 wt % Zn and 32 to 90 wt % Zn, respectively. $Y_3Cd_4Zn_7$ was orthorhombic, $(YCd_3)Zn_2$ was hexagonal with a = 15.103, c = 14.985 Å. Y_2CdZn_{14} was monoclinic with a = 10.234, b = 9.038, c = 6.822 Å, β = 99.40°. (Metals Abstr.)

16543 UNIDIRECTIONAL SOLIDIFICATION OF SOME ALUMINUM ALLOYS. Forsten, Jarl. Helsinki; Technical Univ. (1969). 94p.

Thesis.

An investigation of the structural features of unidirectionally solidified Al alloys (Al–Ta, Al–Hf, Al–Au, Al–Ag, Al–Fe, and Al–Mg) using radiography, optical and electron microscopy is described. Details of the interface structure, in particular the cellular structure and its segregation, are presented for the various alloys. The dependence of cell size on growth rate is described. Three types of substructure are defined, micromosaic, cell, and lineage structure. A net orientation difference was found across the lineage boundaries. Small angle boundaries occurring in Al–Mg alloys are considered to form in the solid state. (Metals Abstr.)

Radiation Effects

Refer also to abstracts 17292, 17651, 18135, 18137, and 18180.

16544 (ANL/EBR-31) POSTIRRADIATION EXAMINATION OF TANTALUM CLADDING FROM PHOTONEUTRON STARTUP SOURCES FOR EBR-II. Strain, R. V.; Cutforth, D. C.; Eschen, V. G. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Sep 1970. Contract W-31-109-eng-38. 28p. Dep. NTIS.

The tantalum cladding from EBR-II antimony–beryllium photoneutron startup sources was examined for evidence of corrosion and changes in physical properties. These sources were exposed to a 4-gpm flow of the EBR-II primary-system sodium during their residence in the reactor. A tantalum-clad source irradiated to a total peak fluence of about 3.4×10^{22} nvt was examined most thoroughly. Optical metallographic examination revealed minor pitting at the outside surface of the cladding but no evidence of serious corrosion or other microstructural changes. Chemical analysis indicated an increase of 709 ppM oxygen, 98 ppM nitrogen, and 11 ppM hydrogen in the irradiated cladding. Changes in density of 2% (maximum) and changes in microhardness as great as 230 DPH were also observed. (auth)

16545 (EURFNR-783) IN-PILE CREEP RUPTURE BEHAVIOR OF CERTAIN AUSTENITIC STEELS AND NICKEL ALLOYS UNDER MULTIAXIAL STRESS. RESULTS OF MOL-2 EXPERIMENTS. Closs, K. D.; Laue, H. J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Translation of report KFK-1152. 51p. Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

This report was abstracted from the original language and appeared in NSA as 24: 48862

16546 (N-70-38376) EFFECT OF REACTOR IRRADIATION ON DUCTILE–BRITTLE TRANSITION AND STRESS–STRAIN BEHAVIOR OF TUNGSTEN. Younger, Charles L.; Wrights, Gilbert N. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sep 1970. 25p. (NASA-TN-D-5991; E-5338). NTIS.

The effect of reactor irradiation at 250°F on the ductile-to-brittle transition behavior of polycrystalline tungsten in the recrystallized condition was investigated. Unirradiated material showed transition at 600°F, but when irradiated to 12×10^{19} fast neutrons/cm^2 the transition occurred at 1460°F. Irradiation strengthened the metal and caused plastic strain to be concentrated within a small-volume element of the test specimen gage section. (auth) (STAR)

16547 (NRL-7211) SM-1A REACTOR PRESSURE VESSEL SURVEILLANCE: IRRADIATION OF FOLLOW-ON CAPSULES IN THE SM-1 REACTOR. Serpan, Charles Z. Jr. (Naval Research Lab., Washington, D. C.). 14 Dec 1970. 14p.

Three capsules containing Charpy V-notch specimens of a duplicate ring-forging of SM-1A reactor pressure-vessel steel were prepared for placement into the SM-1A reactor as part of the continuing vessel surveillance program of that reactor. These capsules plus two more control capsules were irradiated in the SM-1 reactor at 440°F to match the SM-1A reactor pressure-vessel transition-temperature and fluence conditions prior to the SM-1A annealing. The capsules were then furnace annealed under the SM-1A reactor annealing conditions and were reirradiated in the SM-1 to the fluence and transition-temperature conditions of the SM-1A at the end of Core III. Control points were established after each step. Significant differences in flux levels at a point in the SM-1 reactor were noted between an earlier flux-monitor irradiation and the subsequent surveillance-capsule irradiations. These differences were found to be directly related to the two different fuel cores in place at those times. Higher fluxes were generated at the core edge during the flux-monitor irradiation since the core was old and the center was considerably burned out. Lower fluxes were measured at the same core-edge location

XUM

during the surveillance-capsule irradiations, since a new, smaller diameter core peaked in flux toward the center. The information is required for evaluation of the surveillance capsules after they are removed from irradiation in the SM-1A Reactor. (auth)

16548 (ORNL-TM-3064) INFLUENCE OF TITANIUM, ZIRCONIUM, AND HAFNIUM ADDITIONS ON THE RESISTANCE OF MODIFIED HASTELLOY N TO IRRADIATION DAMAGE AT HIGH TEMPERATURE: PHASE I. McCoy, H. E. Jr. (Oak Ridge National Lab., Tenn.). Jan 1971. Contract W-7405-eng-26. 146p. Dep. NTIS.

The influence of small additions of Ti, Zr, and Hf on the mechanical properties of a modified Hastelloy N with the nominal composition Ni-12% Mo-7% Cr-0.2% Mn-0.05% C is described. It deals specifically with test results from numerous, small, laboratory melts and several 100-lb melts from commercial vendors. Additions of Ti, Zr, and Hf had beneficial effects on the properties of the alloy both unirradiated and after irradiation. Irradiation temperature had a marked effect upon the properties of all alloys investigated. Generally, good properties were observed when the irradiation temperature was 650°C or less and poor when the temperature was 700°C or higher. This large effect of irradiation temperature was attributed to coarsening of the carbide structure at the higher temperature. (auth)

16549 (WHAN-FR-30) IRRADIATION-INDUCED CREEP IN AUSTENITIC STAINLESS STEEL. Gilbert, E. R.; Blackburn, L. D. (WADCO Corp., Richland, Wash.). Oct 1970. Contract AT(45-1)-2170. 19p. (CONF-700819-10). Dep. NTIS.

From 2nd International Conference on the Strength of Metals and Alloys, Pacific Grove, Calif.

Data obtained at 43 and 370°C on irradiation-induced creep in annealed austenitic stainless steels 304, 316, and EN58B were correlated in terms of a linear stress dependence, a decreasing creep rate with increasing temperature, an average neutron energy and flux, and the state of stress. The state-of-stress correlation implies that irradiation-induced creep is partly due to volume increase and to shape change. (auth)

16550 (WHAN-SA-9) EFFECT OF COLD WORK ON IRRADIATION INDUCED SWELLING. Holmes, J. J.; Straalsund, J. L. (WADCO Corp., Richland, Wash.). Jul 1970. Contract AT(45-1)-2170. 15p. (CONF-701102-11). Dep. NTIS.

From Meeting of the American Nuclear Society, Washington, D. C.

The effects of cold work on irradiation-induced density changes in AISI Types 316 and 304 stainless steel and Nickel 200 were investigated after irradiation in the EBR-II to a peak fluence of $3 \times 10^{22} n/cm^2$ (E > .1 MeV) at calculated temperatures ranging from 700 to 1400°F. Over the whole range of irradiation temperatures investigated, no swelling was found in the 75% cold worked material. Swelling was also suppressed in the 25% cold worked material except for one irradiation temperature, 900°F, where the density decrease was found to be .08% compared to .26% for the annealed material. Cold work was not as effective in suppressing swelling in the AISI type 304 compared to the 316 stainless steel, for which cold work essentially eliminates swelling. Cold work was also found to be effective in reducing swelling in Nickel 200. For irradiation temperatures below 1000°F, 50% cold work reduced the swelling in annealed Nickel 200 by about 50%. However, for irradiation temperatures of 1100°F and above, no benefits were obtained. It appears probable that the cold work had recovered at the high irradiation temperatures. A part of the information presented in the report is included as an addendum written by the listed authors and including one additional author; H. R. Brager. (J.R.D.)

16551 GROWTH OF VOIDS IN NICKEL IN A HIGH-VOLTAGE ELECTRON MICROSCOPE. Norris, D. I. R. (Berkeley Nuclear Labs., Eng.). Phil. Mag.; 23: 135-52(Jan 1971).

Thin foils of nickel were electron-irradiated with the beam of a high-voltage electron microscope. In specimens previously ion-bombarded, voids are observed to grow at temperatures between 280 and 480°C. The results are compared with those for neutron irradiation and are found to be basically similar. Differences are a sharp cut-off at high temperatures, thought to be a thin foil effect, and a much lower proportion of vacancies joining voids in the electron irradiation case. The voids are usually cubes, often elongated, with (100) faces. The size distribution fits a negative exponential function. Details of microscopic processes occurring during irradiation were followed. Void growth is only found in the vicinity of a dislocation or a coherent twin boundary, which absorbs interstitials preferentially. In perfect crystal, a void absorbs more interstitials than vacancies and shrinks. While some voids vanish, new ones continually appear. Occasionally two voids grow together and coalesce. The rate-controlling mechanism for growth of a single void is thought to be absorption of vacancies everywhere on a void surface. Dislocation movement determines the lifetime of each void and therefore the overall volume change. (auth) (UK)

16552 METALLIC BERYLLIUM BEHAVIOR IN SM-2 REACTOR. Chechetkina, Z. I.; Gol'tsev, V. P.; Klimenkov, V. I.; Votinov, S. N.; Tsykanov, V. A. At. Energ. (USSR); 29: 174-7 (Sep 1970). (In Russian).

Beryllium, irradiated at the SM-2 reactor, was investigated to estimate the radiation damage and to establish the service stability and structural changes of metal in relation to the irradiation dose and helium and tritium fission products accumulation. The influence of some technological factors on the beryllium radiation strength was also studied. Some recommendations on beryllium usage in conditions analogous to those of the reactor SM-2 are given. (auth)

16553 A MEASUREMENT OF RADIATION HARDENING AND DEFECTS IN IRRADIATED PLATINUM. Inal, Osman Tugay. New York; Columbia Univ. (1969). 95p. University Microfilms Order No. 70-17,019.

Thesis.

An experiment was performed to study the activation energy for dislocation cutting of defects in high purity platinum. The platinum, 99.999+% pure, was irradiated to a fluence of 2×10^{18} nvt ($E \geq 1.45$ MeV). After this irradiation the samples were annealed at 25°C to 500°C and tensile tested at various temperatures between room temperature and 4.2°K. A pronounced temperature dependence of the yield stress was observed in the irradiated specimens. The corresponding defect structures were studied by field-ion microscopy and depleted zones were observed to be the predominant defect aggregates in irradiated platinum. A considerable decrease in the irradiation hardening was observed upon annealing and field-ion microscope observations showed that this was due to the changes introduced in the size and density of depleted zones by annealing. The results obtained were found to be consistent with the predictions of Seeger's theory of irradiation hardening and the activation energy for dislocation cutting at zero stress was evaluated, through this model, to be 1 eV. (Diss. Abstr. Int., B)

16554 NEUTRON ENERGY-DEPENDENT DAMAGE FUNCTION FOR ANALYSIS OF AUSTENITIC STEEL CREEP DATA. McElroy, W. N.; Dahl, R. E. Jr.; Gilbert, E. R. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Nucl. Eng. Design; 14: 319-31(Nov 1970).

Proper correlation and subsequent application of irradiation-effects data for materials exposed in different reactor environments depend upon a knowledge of the energy dependence of neutron damage. A theoretical model of neutron damage in austenitic steel was adjusted with available creep-strain data for austenitic steel irradiated at temperatures below ~400°C. This procedure yielded a damage function for the neutron-energy dependence of irradiation-induced creep-strain. Although the derived damage function correlates available creep data, it is only roughly defined and is presented to meet immediate demands for such correlation. Additional and more accurate flux-spectral, fluence and property-change data for more test reactor environments are required to confirm the adequacy of the damage function. As a means of interpreting and correlating available test-reactor data for application to different environments, the present damage function will help establish proper engineering design requirements for use of austenitic steels in fast test, thermal test, and power reactors. The damage function is now being used to analyze irradiation conditions in the Fast Test Reactor (FTR) among others. (auth)

16555 ELECTRON-MICROSCOPE STUDY OF RADIATION DAMAGE BY FISSION FRAGMENTS IN VANADIUM. Heerschap, M.; Schueller, E. (European Atomic Energy Community, Petten, Netherlands). J. Nucl. Mater.; 38: 221-5(Feb 1971).

The defect structure introduced into vanadium foils by fission fragments at about 50°C was studied. The irradiated foils were heated in an ultrahigh vacuum furnace at 200 to 600°. Resolvable dislocation loops became visible at 400 to 600°C, whereas all loops disappeared at 600°C. (G.M.C.)

16556 ACCELERATION OF CHEMICAL DIFFUSION UNDER IRRADIATION IN THE ALUMINUM–MAGNESIUM SYSTEM. Moreau, G.; Cornet, J. A.; Calais, D. J. Nucl. Mater.; 38: 197-202 (Feb 1971). (In French).

A pronounced enhancement of chemical diffusion was observed below 350°C under fast neutron irradiation (flux = 3.6×10^{12} n/cm²). Thus, the diffusion coefficient of magnesium in aluminum extrapolated to infinite dilution was increased by a factor of ten at 180°C under irradiation. The activation energy changed from 31 to 24.5

kcal/mole. By means of Dienes and Damask's analysis, it was shown that the excess point defects, both vacancies and interstitials, were eliminated simultaneously by direct recombination and by migration to sinks (i.e. dislocations) the concentration of which depended on the annealing temperature and the integrated flux. The role of vacancy-impurity complexes is emphasized. (auth)

16557 CYCLOTRON BOMBARDMENT TO SIMULATE FAST NEUTRON DAMAGE IN REACTOR MATERIALS. Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). pp 273-81 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The basic physical considerations underlying the production of radiation damage by both energetic charged particles (>1 MeV) and fast neutrons are discussed. The relevant formulae are derived in order to make direct comparisons between the primary recoil spectra and the total damage produced by such irradiations. As an example the damage produced in an iron sample is calculated in detail. Finally, the result of a typical simulation experiment is given to illustrate the theoretical conclusions. (auth) (UK)

16558 CYCLOTRON SIMULATION OF NEUTRON-TRANSMUTATION PRODUCED GASES IN REACTOR CLADDING AND STRUCTURAL MATERIALS. King, R. T. (Oak Ridge National Lab., Tenn.). pp 294-318 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

Cyclotrons were used to simulate the nearly uniform concentrations of helium produced during neutron irradiation of metals by (n,α) reactions. Gas was injected into flat sheet specimens by degrading monoenergetic ion beams with either a stationary or a rotating energy moderator of continually-varying thickness. The effects of cyclotron-injected helium on the mechanical properties of Type 304 stainless steel, a potential cladding material for Liquid Metal Fast Breeder Reactors, were investigated. Helium concentrations ranging from 0.083 to 20.0 atomic ppM severely reduced the ductility of Type 304 stainless steel in both creep and tensile tests over the ranges of strain rate and temperature for which the material fails intergranularly. It was experimentally demonstrated, in agreement with theoretical calculations, that simply passing similar currents of α-particles completely through stainless steel did not produce sufficient displacement damage to cause significant changes in ductility. The resistance of a 0.2% Ti-Type 304L stainless steel to helium embrittlement has been demonstrated by cyclotron bombardment techniques. The role of helium in low-ductility failures of aluminum reactor components at ~150°C after fast neutron irradiation was also investigated. Tensile data for aluminum alloys containing 5.0 atomic ppM He showed that helium generated by ^{27}Al(n,α) reactions reduces the elevated-temperature ductility of the 1100 and X8001 aluminum alloys, while the properties of the 6061 and 895 SAP alloys were not affected. (auth) (UK)

Ceramics and Cermets

Refer also to abstracts 16398, 16399, and 16412.

16559 (NYO-1710-100) SUMMARY REPORT FOR RESEARCH ON GRAPHITE, APRIL 1, 1970–MARCH 31, 1971. Walker, P. L. Jr.; Kline, D. E.; Thrower, P. A. (Pennsylvania State Univ., University Park. Dept. of Material Sciences). 20 Dec 1970. Contract AT(30-1)-1710. 50p. Dep. NTIS.

Research and development progress is reported on carbonization of anthracene, carbon formation from CO, graphitization of pyrolytic carbon, gas-graphite interactions, solid-state reactions, radiation effects on mechanical properties of graphite, and radiation damage in graphite. (J.R.D.)

Corrosion and Erosion

Refer also to abstracts 15847, 16410, and 16458.

16560 OXIDATION OF THORIUM NITRIDES. Ozaki, Satoru; Kanno, Masayoshi; Mukaibo, Takashi (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: 41-4(Jan 1971).

An experimental study was made of the oxidation of two thorium nitrides ThN and Th_3N_4, in oxygen under a pressure of $\frac{1}{5}$ atm. The Th_3N_4 was prepared by reacting thorium hydride with N_2 gas, and the ThN by decomposing Th_3N_4 in vacuo. The thorium nitrides were identified by x-ray powder diffractometry. The values of N/Th ratio were determined by chemical analysis to be 0.90 ~ 0.92 for ThN and 1.22 for Th_3N_4. Powder specimens of both thorium nitrides were isothermally oxidized in the temperature range of 340 ~ 480°C. The oxidation behavior of ThN powder was found to be independent of oxygen pressure ($\frac{1}{5}$ ~ 1 atm). The reaction kinetics of both thorium nitrides were found amenable to representation by linear plots for the most part of the reaction. The apparent activation energies were 18 ± 3 kcal/mole for ThN and 15 ± 2 kcal/mole for Th_3N_4. X-ray examination revealed the oxidation product of both nitrides to be ThO_2. No other product was detected. (auth)

Preparation and Fabrication

Refer also to abstracts 15473, 15727, 16432, and 16582.

16561 (JUL-686-RW) COATING OF FUEL ELEMENT PARTICLES BY PROPENE PYROLYSIS IN 1-INCH AND 2-INCH FLUIDIZED BED. Gyarmati, E.; Nickel, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Aug 1970. 35p. (In German). Dep. NTIS (U. S. Sales Only).

Results of studies on pyrolytic carbon deposition from propene (C_3H_6) and methane (CH_4) are presented. It was found that pyrolytic carbon with different structure such as columnar, granular, dense-isotropic, sooty-isotropic, and porous can be deposited on fuel particles in 1- and 3-inch fluidized beds dependent on the propene concentration and the deposition temperature. Methane decomposition leads to laminar, granular, isotropic, and columnar pyrolytic carbons with the structure depending on the CH_4 concentration and temperature. Fuel particles with isotropic high-density pyrocarbon show the best irradiation behavior. Pyrolysis of propene within a temperature range between 1250 and 1350°C results in a high density isotropic layer which is comparable to layers produced with methane above 1800°C. The density of the PyC deposited by pyrolysis of C_3H_6 reaches a minimum at a deposition temperature of 1500°C and increases with further increase in temperature. This behavior does not depend on the bed geometry. When the PyC is deposited from CH_4 there is also a minimum in density at 1500°C. The anisotropic orientation of PyC microcrystallites depends on hydrocarbon concentration, deposition temperature, and bed geometry. The value of the Bacon Anisotropic Factor (BAF) for the pyrocarbon deposited above 1500°C from methane is ≤1.1, dependent on the CH_4 concentration. This low BAF value can be achieved by propene pyrolysis at 1250°C at an appropriate C_3H_6 concentration. PyC with high density and isotropic structure from propene is deposited on fuel particles between 1250 and 1350°C. The apparent crystallite size (L_c) of this PyC ranges between 20 and 60 Å depending on the C_3H_6 concentration and the bed geometry. PyC, produced by CH_4 pyrolysis which shows comparable density and structure can only be deposited between 1800 and 2100°C. The L_c values then vary between 70 and 140 Å. The efficiency in pyrocarbon depends for both gases on decomposition temperature and concentration. This efficiency for propene is in the temperature range (1250 to 1350°C) between 45 and 60% and for methane (1800 to 2100°C) above 70%. With propene, higher deposition rates for dense-isotropic PyC are achieved than with methane. For this reason, propene used as the pyrolysis gas gives an economical advantage. In consequence of the low deposition temperature for the production of isotropic, high-density pyrocarbon by the pyrolysis of propene, the layers of the coated particles show a lower heavy metal contamination than the pyrocarbon layers obtained by methane pyrolysis. (auth)

16562 (NP-18650) SOME TECHNIQUES FOR PREPARATION OF CERAMIC FUELS IN PNC, JAPAN. Muto, T.; Matsumoto, K.; Naruki, K.; Suzuki, S. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Oct 1970. 28p. (N-841-70-29). Dep. NTIS (U. S. Sales Only).

Preparation techniques for fast reactor ceramic fuels are described. Two methods related to orthodox processes for preparation of oxide and carbide pellets are under development at PNC. In the descriptions stress is placed on solution of problems associated with high-grade homogeneity of plutonium and uranium compatible with low density. Data on the oxygen contents of UC pellets from the carbothermic reduction process at various preparation conditions are included. Other techniques concerned with the modified sol-gel processes are also described by which shards, microspheres, and pellets of UO_2 and UC are prepared. (auth)

16563 ANTI-FRICTION MATERIAL. Blouet, Jean; Courcier Francois; Courtel, Robert; Gras, Rene; Risler, Francis (to Commissariat a l'Energie Atomique). British Patent 1,218,906. 13 Jan 1971. Priority date 27 Jun 1968, France.

XUM

An antifriction material suitable for dry bearings is described. The material is composed of chromic oxide and zirconium oxide, the ZrO_2 comprising 5 to 25% by weight. It is useful in high temperatures, corrosive atmospheres, and in vacuums. (J.R.D.)

16564 LITHIUM SULPHATE ULTRASONIC TRANSDUCER. Dixon, Norman E.; Coleman, William J. (to United States Atomic Energy Commission). U. S. Patent 3,546,012. 8 Dec 1970. Filed 27 Mar 1968.

An ultrasonic lithium sulfate transducer is fabricated by vapor depositing a backing material under vacuum on one side of a lithium sulfate crystal and etching the other side with water. After etching is completed, a quartz lens is vapor deposited under vacuum on the other side of the crystal and a destructive interference lens is applied to the quartz lens. (Offic. Gaz.)

16565 STUDY ON THE REMOVAL OF PYROLYTIC CARBON AND SILICON CARBIDE COATINGS. Szterk, Lucjan (Inst. of Nuclear Research, Warsaw). Nukleonika; 15: 425-36(1970). (In Polish).

A method is described of removing pyrolytic carbon and silicon carbide coatings from granulated ceramic fuels of the $(U,Th)C_2$ type used in HTGR reactors. The composition of the etching solutions used for the removal of pyrolytic carbon and silicon carbide coatings is given, the kinetics of the process is determined, and the mechanisms of reactions accompanying the dissolution of SiC are discussed. Etching for 5 minutes removed 6 to 8 μ of the pyrolytic carbon coating and 3 to 4 μ of the silicon carbide. The method developed will be applied for examination of the concentration profiles of the fission products in coatings of that type, after long-term activation in a nuclear reactor. (auth)

16566 LAWS OF ELECTRIC SPARK FRACTURE OF REFRACTORY METALS AND THEIR COMPOUNDS WITH CARBON BORON. Samsonov, G. V.; Lemeshko, A. M. Elektron. Obrab. Mater.; No. 6, 3-7(1969). (In Russian).

Results of investigations are presented on electrode-anode erosion of refractory metals and their carbides and borides during electric spark machining under pure RC-circuit conditions during the action of single discharges, and under conditions of machining on series electric spark machine tools. The interrelation of the characteristics of erosion attack of the electrode materials with their electron structure is established. It is demonstrated that the electromachining resistance of metals increases with an increase in the statistical weight of the atoms with stable d^5-configurations. The erosion resistance of carbides of refractory metals increases with a decrease in localization of the valence electrons of the carbon atoms in the sp^3-configuration, insuring directional rigid bonds and stabilization of these configurations. The erosion resistance of borides increases with a decrease in stabilization of the structural elements of boron atoms as the transition takes place from metals of groups V and VI. In the pure condition range, the fracture of the compounds is of a brittle nature. The proportion of this fracture is reduced with a decrease in the localization of electrons on the cores of the nonmetal atoms. (JPRS)

16567 PYROLYTIC CARBON STRUCTURES AND PROCESS FOR MAKING SAME. Bokros, Jack C.; Chin, Jack; Price, Robert J. (to United States Atomic Energy Commission). U. S. Patent 3,547,676. 15 Dec 1970. Filed 15 Feb 1966.

An article was heated to a high temperature in contact with a gas stream carrying a carbon containing substance. The heating, flow rate and size of the articles were controlled to deposit a dense isotropic pyrolytic crystalling carbon on the surfaces of the articles. The deposited carbon, per se, having an isotropic crystalline structure, a density of at least 1.8 grams per cc., and a Bacon anisotropy factor between about 1.0 and 1.3 had good mechanical strength and excellent dimensional stability under prolonged exposure to high temperature and neutron irradiation. (Offic. Gaz.)

Properties Evaluations

Refer also to abstracts 15629, 15856, 16459, 16472, 17274, 17300, 17313, 17325, 18098, 18171, 18174, and 18246.

16568 (BMI-1894) DEVELOPMENT AND OPERATION OF AN APPARATUS FOR IN-PILE CREEP STUDIES OF LMFBR FUELS. Robinson, Richard A.; Basham, Samuel J.; Perrin, James S. (Battelle Memorial Inst., Columbus, Ohio). Jan 1971. Contract W-7405-eng-92. 26p. Dep. NTIS.

An apparatus for obtaining data on the compressive creep of ceramic fuel materials during irradiation was designed and operated. The specimen was fabricated in the shape of a hollow cylinder to reduce temperature gradients caused by fission heating and to allow placement of creep probes near the ends of the specimen. A compressive load was applied to the specimen through a bellows-sealed, gas-actuated piston. Specimen temperatures were maintained by a resistance-wire heater. Axial creep of the fuel was measured by transmission of the motion through bellows-sealed probes linked to a pneumatic displacement transducer with a variable-area orifice. The apparatus was designed to operate with fuel temperatures in the range from 900 to 1300°C, stress levels of 1,000 to 12,000 psi, and fission rates ranging up to 2×10^{13} fissions/(cm^3) (sec). (auth)

16569 (IS-2300, pp 1-5) CERAMIC ENGINEERING DIVISION. Hunter, O. Jr.; Wilder, D. R. (Ames Lab., Iowa).

From Ceramic Engineering, Chemical Engineering, Chemistry, Mathematics and Computer Science, Metallurgy, Physics, and Reactor Divisions annual summary research report, July 1969-June 1970.

Research progress is reported for investigations on diffusion in Y_2O_3 and rare earth sesquioxides, solid electrolyte behavior in ThO_2, elasticity of rare earth oxides, elastic properties of thermal shock-resistant materials, and thermal diffusivity of ceramic materials. (J.R.D.)

16570 STRENGTH RECOVERY PHENOMENA BY ANNEALING CEMENTED CARBIDES WITH CRACKS. Hara, Akio; Yazu, Shuji. Sumitomo Elec. Tech. Rev.; No. 14, 97-105(Nov 1970).

It was considered that some braking phenomena against crack propagation should exist at high temperatures if the fracture of the cemented carbide was thought of from the point of view of crack propagation. A model experiment studied this phenomena. A WC-5% Co and a WC-6% Co alloy were used as specimens. An indentation was made by a Vickers hardness tester on a lapped surface of the specimen. From the corners of the indentation, four sharp cracks occurred. The specimens with the cracks were annealed in a vacuum furnace at the temperatures of 400 to 1,200°C for a time of between 1 and 15 min. The transverse rupture strength before and after annealing was measured, setting a pair of cracks perpendicular to the maximum tension direction in the lower surface of the specimen. The change in the crack by annealing was observed by microscope. The strength, which decreased greatly due to the sharp cracks, recovered even by annealing at 400°C, and was increased with an increase in temperature. The recovery of the strength was greatest for the time of 1 and 5 min. As reasons for the strength recovery, increase of radius of curvature at the top of the crack, caused by the gradual filling up of cobalt mainly by self-diffusion, and above 1,000°C the effect of the partial disappearance of the crack, are considered. The degree of cobalt movement nearly coincided with the theoretically calculated value based on the sintering theory of Kuczynski. (auth)

16571 STUDY OF THE THERMOELECTRIC PROPERTIES AND THERMAL CONDUCTIVITY OF USi_2, VSi_2, MoCrSi, AND UC. Terekhov, G. I.; Tagirova, R. Kh.; Ivanov, O. S. Izv. Akad. Nauk SSSR, Metal.; No. 3, 177-80(May-Jun 1970). (In Russian).

Thermoelectric properties and heat conductivities of these compounds were studied at temperatures up to their melting or decomposition points. Conductivity of USi_2 shows polymetallic characteristics while VSi_2 and UC have characteristics similar to single metals. The compound $CrSi_2$ has semiconductor properties after addition of 10% Mo which retain relatively high values of thermoelectric potential at 1300°C. Data on the thermoelectric properties of CrMoSi are included. (tr-auth)

16572 ROLE OF TaC IN WC-Co ALLOYS. Meerson, G. A.; Panov, V. S. Izv. Akad. Nauk SSSR, Metal.; No. 3, 209-11(May-Jun 1970). (In Russian).

Results of studies showed that the addition of TaC to WC-Co alloys increases the operating properties of these systems at the expense of the binding phase, especially at higher temperatures. The most favorable combination for use in hard tips made of WC-Co with added TaC is a composition consisting of 7 to 12% Co and 2 to 5% TaC. (tr-auth)

16573 THE INFLUENCE OF STRESSES ON THE COERCIVE FORCE, THE WORK OF CRACK FORMATION ACCORDING TO PALMQVIST, AND THE ABRASIVE BEHAVIOUR OF HARD METALS. Jung, Otto; Dawihl, Walther; Altmeyer, Georg (Univ. Saarlandes, Saarbrucken). Z. Metallk.; 61: 898-905(Dec 1970). (In German).

An investigation was carried out in order to show to what extent the coercive force, the work of crack formation according to Palmqvist, and the abrasion resistance of hard metals were influenced by stresses and heat treatment. Neither tensile (max 60 kg/mm^2) nor compressive stresses (max 90 kg/mm^2) changed the coercive force of hard metals of the P20 group of application to any noticeable extent. In the case of molten cobalt the coercive

force increased under compressive load and decreased under tensile load. Heat treatment at 1000°C reduced the coercive force of the hard metal sample with the highest values. This was due to the increase in width of the cobalt layers. For hard metals of the P 10 and P 20 groups of application a mutual dependence between coercive force and work of crack formation did not exist. In the case of the coarse-grained WC-cobalt alloy B 05, however, such a dependence existed. According to this the samples with the highest values of the coercive force were the most brittle ones. After heat treatment at 1000°C the work of crack formation and the hardness of all samples belonging to the P 20 group of application were decreased because the stresses due to machining were reduced. Shrinkage stresses did not influence the work of crack formation. Tensile stresses up to 20 kg/mm² did not change the abrasion resistance of the P 20 samples of high, medium, and low coercive force. The respective H_c regions differed, however. The samples having the highest coercive force showed the smallest amount of abrasion in the wear pot and the least roughness after the abrasion test. This was due to the higher number of extremely thin streaks of cobalt. The abrasion resistance of the hard metals of the P 20 group of application was improved by compressive shrinkage stresses. Heat treatment at 1000°C lowered the abrasion resistance in the case of the P 20 samples of medium and low coercive force but not in those with high values of H_c. The model abrasion tests give information on the elementary processes of wear on the free surface of hard metals used for machining of ferrous materials. (auth)

16574 RELEASE OF FISSION GASES FROM SINTERED UO_2. Stevanovic, Momcilo; Sigulinski, Fedor (Boris Kidric Inst. for Nuclear Science, Belgrade). Nukl. Energ.; 4: No. 6, 8-12(1967). (In Serbo-Croatian).

Mechanisms that control the separation of fission gases from sintered UO_2 at various burn-up rates, effusion, knock-out, and diffusion, increased by larger separation of fission gases which accompanied structural changes in the fuel. The separation of fission gases from power reactor fuels is studied. There is also an analysis of the impact of factors such as temperature, fuel characteristics, and burn-up rates. (auth)

16575 THERMAL EXPANSION OF CeO_2, Ho_2O_3, AND Lu_2O_3 FROM 100 to 300°K BY AN X-RAY METHOD. Gupta, Murari L.; Singh, Sohan (Howard Univ., Washington, D. C.). J. Amer. Ceram. Soc.; 53: 663-5(Dec 1970).

Thermal expansion of CeO_2, Ho_2O_3, and Lu_2O_3 was determined from 100 to 300°K by a back-reflection x-ray technique. The variation of thermal expansion with temperature was the same as that of specific heat for CeO_2 and Ho_2O_3; these oxides obey the Grueneisen model of thermal expansion in the temperature range studied. (auth)

16576 ELASTIC AND THERMODYNAMIC PROPERTIES OF TRANSITION METAL CARBIDES. Chang, Y. A. (Univ. of Wisconsin, Milwaukee); Toth, L. E.; Tyan, Y. S. Met. Trans.; 2: 315-20(Jan 1971).

Values of the Debye temperature, θ_E, for a number of refractory carbides were calculated from elastic constant data and then compared with those of the Debye temperature, θ_D, as derived from low-temperature C_p data. It was found that an apparent discrepancy existed in the literature between the values of θ_E and θ_D for these carbides. However, when the same units were used, agreement of 10% or better between the values of θ_E and θ_D was found for all the carbides with the exception of MoC_{1-x}. A discrepancy of 10% is reasonable based on an analysis of both the experimental and theoretical difficulties associated with the evaluation of θ_E and θ_D for this class of materials. All the elastic constant data used were taken from the literature. Values of C_p for TiC, HfC, and WC were measured in the present study from 1.5 to 15°K. These values in addition to the literature data were used in deriving θ_D values. A correlation of the bulk modulus with interatomic spacing is presented for these refractory carbides. Based on this correlation, the bonding forces responsible for the cohesion of this class of materials are discussed. (auth)

16577 OBSERVATIONS ON THE NATURE OF HYDROUS ZIRCONIA. Whitney, E. Dow (Carborundum Co., Niagara Falls, N. Y.). J. Amer. Ceram. Soc.; 53: 697-8(Dec 1970).

The dehydration behavior of hydrous zirconium dioxide was studied at 200 to 1000°K. These experimental results were used to interpret the structure of the zirconyl ion. (G.M.C.)

16578 CARBON REDUCTION OF NIOBIUM PENTOXIDE TO NIOBIUM. Kolchin, O. P. Tsvetn. Metal.; No. 7, 46-8(Jul 1970). (In Russian).

The industrially important reduction of niobium from its pentoxide by carbon includes the complete, direct reduction and the formation of an intermediate, partially carbide containing stage. The phase composition of the products of the latter, incomplete reduction of Nb_2O_5 by the carbothermic method was investigated in the 1050 to 2300°C range, in order to determine the reduction mechanism and the thermodynamic equilibrium. The overall reduction reaction may be considered as a series of partial reactions which depend on the ambient temperature. The pentoxide was first reduced to the dioxide by the carbon of the higher carbide. The niobium carbide formed a phase with a variable composition and a wide region of homogeneity in the $NbC_{0.71}$ to $NbC_{0.99}$ range. At the start, from 675°C on, the reduction was based on the evaporation of the pentoxide; above 1150°C, the Nb_2O_5 dissociated strongly. Between 1000 and 1200°C, reduction by CO prevailed, including its regeneration by the CO_2 + C reaction. The potential contribution of niobium oxycarbides was not examined in detail. The identified processes probably may be applied with slight modifications to the carbothermic reduction of vanadium and tantalum. (TTT)

16579 HIGH TEMPERATURE ENTHALPY AND RELATED THERMODYNAMIC FUNCTIONS OF SOME MATERIALS FROM THE URANIUM–OXYGEN SYSTEM. Marchidan, D. I.; Ciopec, M. (Centre of Physical Chemistry, Bucharest). Rev. Roum. Chim.; 15: 1287-1301(Sep 1970).

Enthalpy data are reported for $UO_{2.125}$ and $UO_{2.63}$ over a temperature range from 300 to 1300°K. To this purpose $UO_{2.125}$ was sealed in a quartz capsule evacuated under argon and subsequently introduced into a platinum container; $UO_{2.63}$ was inserted into a platinum capsule sealed in the air. A drop technique was employed in conjunction with an isothermal-jacket, block-type calorimeter in order to measure the heat release which was then converted into enthalpies. Prior to these tests similar measurements were carried out on the enthalpy of alpha-alumina (NBS standard substance) up to 1300°K. The results were found to be in good agreement with the existing high temperature data and hence the accuracy of the technique. The thermodynamic functions were calculated from experimental results. A comparison is made between the observed data and the previous values. (auth)

16580 DIFFUSION OF CARBON IN THE CARBIDES OF NIOBIUM. Fujikawa, Yoshimichi (Osaka Univ.); Son, Pongun; Miyake, Masanobu; Sano, Tadao. J. Jap. Inst. Metals; 34: 1259-63(Dec 1970). (In Japanese).

The reaction between niobium and graphite over the temperature range 1700 to 2200°C was investigated. The reaction products were found to be Nb_2C and NbC which formed between the graphite and the metal. Parabolic growth behavior was observed for both phases. Expressions for the rate constants for layer growth are given. The diffusion coefficients of carbon in Nb_2C and NbC were estimated to be $D^c_{Nb_2C} = 2.3 \times 10^{-3} \exp[-(39.9 \pm 3.9/RT)\text{kcal/mole}]$ cm^2/sec and $D^c_{NbC} = 0.35 \exp[-(74.2 \pm 2.7/RT)\text{kcal/mole}]$ cm^2/sec, assuming that D is independent of concentration. (auth)

16581 SELF-DIFFUSION MEASUREMENT OF OXYGEN IN UO_2 BY THE NUCLEAR REACTION $^{18}O(p,\gamma)^{19}F$. Hadari, Z. (Nuclear Research Centre, Negev, Israel); Kroupp, M.; Wolfson, Y. J. Appl. Phys.; 42: 534-5(Feb 1971).

The $^{18}O(p,\gamma)^{19}F$ nuclear reaction has been employed for measuring self-diffusion coefficients, in sintered $U^{18}O_2$ at temperatures between 925 and 1425°C. This method allows the determination of concentrations in a well-defined diffusion layer due to the resonant nature of the reaction. (auth)

16582 FILAMENT-WOUND COMPOSITES IN PERSPECTIVE. Morris, E. E. (Aerojet-General Corp., Azusa, Calif.). pp 96-114 of Proceedings of the First Joint Aerospace and Marine Corrosion Technology Seminar, Los Angeles, California, July 10–12, 1968. Houston, Tex.; National Association of Corrosion Engineers (1969).

From 1st Joint Aerospace and Marine Corrosion Technology Seminar, Los Angeles, Calif. See CONF-680732.

A review and summary are presented on properties and design of filament-wound composite structures. Emphasis in the discussions is on materials, fabrication methods, properties of composites, compared with those of metals, and uses of composites. (J.R.D.)

16583 GRAIN-BOUNDARY GROOVING OF UC. Nicholas, M. G.; Hodkin, E. N. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 38: 234-5(Feb 1971).

Surface diffusion was found to be the controlling mechanism for grain-boundary grooving of polycrystalline uranium monocarbide at 1100 to 1600°C. (G.M.C.)

16584 CALCULATION ON THE SIZE DISTRIBUTION OF INTRAGRANULAR BUBBLES IN IRRADIATED UO_2. Speight, M.

XUM

V. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater.; 38: 236-8(Feb 1971).

A model is given for the calculation of the size distribution of intragranular bubbles in irradiated uranium dioxide. This extended Turnbull's model that described the size and concentration of intragranular bubbles in irradiated uranium dioxide but assumed that the bubble size was uniform. (G.M.C.)

16585 STUDY ON THE DIFFUSION OF RADIOISOTOPES INTO PYROLYTIC CARBON AND SILICON CARBIDE COATINGS. Szterk, Lucjan (Inst. of Nuclear Research, Warsaw). Nukleonika; 15: 515-30(1970).

The concentration profiles of the radioisotopes: ^{95}Zr, ^{106}Ru, ^{137}Cs, $^{140}Ba-La$, and ^{144}Ce (fission products of uranium and thorium) in pyrolytic carbon and silicon carbide coatings on granulated ceramic fuels of the $(U,Th)C_2$ type, after a long-term activation in a nuclear reactor, were determined. The degree of penetration of the radioisotopes was determined by method developed earlier for removal of the coatings, and γ-spectrometric measurements of the solutions obtained from etching. A method of selecting the activated granules for examination is forwarded. Some physical phenomena and the mechanism of migration of the studied isotopes under the conditions of a fission process, and the crystal structure of surrounding materials are discussed. (auth)

16586 MICROCHARACTERIZATION OF REACTION ZONE BETWEEN UO_2 AND Ni–Ti ALLOY. Spengler, C. J.; Bratton, R. J. (Westinghouse Research Labs., Pittsburgh). J. Nucl. Mater.; 38: 217-20(Feb 1971).

The segregation and reactions between UO_2 and Ni/0.28 wt % Ti alloy at 1500°C in argon were studied. There was a definite reaction zone between the UO_2 and the Ni/0.28 wt % Ti alloy at every place along the original interface; however, the thickness of the reaction zone varied from less than 1 μm to about 10 μm. The reaction zone consisted of a matrix phase of TiO_2 in which there was a second phase. This phase on the basis of uncorrected line-intensities, consisted of UO_2 and TiO_2 in the approximate ratio of 1:5. There was titanium diffusion into the bulk UO_2 to a depth of 3 μm ± 1.5 μm to a maximum concentration of about 1 wt %. There was titanium enrichment in the bulk nickel over a distance of 5 μm ± 1.5 μm to a maximum level of 1 wt %. There was no detectable nickel-diffusion in the bulk UO_2. (auth)

16587 THERMAL DIFFUSION OF OXYGEN IN HYPERSTOICHIOMETRIC URANIA WITH VERY LOW CARBON CONTENT. Adamson, M. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 38: 213-16(Feb 1971).

With C impurities, in a hyperstoichiometric uranium dioxide fuel, a CO/CO_2 gas phase mechanism operated which resulted in the migration of excess oxygen into the center of the fuel. A thermal gradient across a pure specimen should result in the transport of oxygen from high to low temperature regions. Thermal diffusion effects in hyperstoichiometric uranium dioxide were studied after the carbon content was reduced to ≤ 5 ppM. After a series of diffusion anneals in a temperature gradient of 1590 to 865°C it was found that the CO/CO_2 oxygen transfer mechanism was providing the favored path for thermal diffusion. It was concluded that efforts to reduce the carbon content of oxide fuels to the level at which oxygen redistribution via CO/CO_2 transport will no longer occur are unlikely to be successful, especially on the production scale. (G.M.C.)

16588 DISTRIBUTION OF INTRAGRANULAR FISSION GAS BUBBLES IN UO_2 DURING IRRADIATION. Turnbull, J. A. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater.; 38: 203-12(Feb 1971).

A model is presented describing the nucleation and growth of intragranular fission gas bubbles during the irradiation of uranium dioxide. The bubbles are considered to be heterogeneously nucleated in the wake of energetic fission fragments where they grow by collecting gas by atomic diffusion for a length of time controlled by a re-solution process. The model satisfactorily explains the variation of size and concentration of bubbles with temperature as observed by electron microscopy of irradiated material. (auth)

16589 CATION SELF-DIFFUSION IN UN_{1+x}. Reimann, D. K.; Kroeger, D. M.; Lundy, T. S. (Oak Ridge National Lab., Tenn). J. Nucl. Mater.; 38: 191-6(Feb 1971).

Tracer diffusion of ^{233}U into large-grained polycrystalline UN was investigated by the alpha energy degradation method. This was a nondestructive technique in which the diffusion coefficient was deduced from the shape of the energy spectrum of the ^{233}U alpha-particles emitted from the surface of the sample after diffusion. In the ranges of 1600 to 1850°C and 0.1 to 200 torr nitrogen overpressure, the diffusion coefficient was a strong function of nitrogen pressure and almost independent of temperature at a given nitrogen pressure. These results and those of Holt and Almassy for nitrogen diffusion in UN are in qualitative but not quantitative accord with a simple defect chemistry calculation. (auth)

16590 THERMODYNAMIC PROPERTIES OF THE ACTINIDE NITRIDES. Tagawa, Hiroaki (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 12: 658-65(Nov 1970). (In Japanese).

The present state of knowledge of the thermodynamic properties of the actinide nitrides is reviewed. Few thermodynamic data are available today for these nitrides except for the case of UN. The thermal functions for uranium nitrides are derived, and those for ThN and PuN are estimated. (auth) (Japan)

16591 POROSITY CORRECTION FACTOR FOR THE THERMAL CONDUCTIVITY OF CERAMIC FUELS. Marino, G. P. (Bettis Atomic Power Lab., West Mifflin, Pa.). J. Nucl. Mater.; 38: 178-90(Feb 1971).

The variation of the porosity correction factor, β, with temperature and pore shape was studied by using the Fricke equation for the thermal conductivity of a two-phase medium containing the second phase as randomly distributed ellipsoids. The temperature variation occurred via a parameter, γ, related to the conductivity of the pores. The effect of pore shape was determined via the axial ratio, ϵ, of oblate or prolate ellipsoidal pores. The results are presented graphically in curves showing the variation of β with γ and ϵ. The model was applied to actual conductivity data of ThO_2 and ThO_2-UO_2 specimens in an effort to correlate the general porous structure typical of ceramic fuels to the parameters (ϵ and γ) in the Fricke equation. It was shown that the β factor for ceramic fuels could be related to their general microstructure and pore conductivity in a self-consistent mathematical framework. The technique, therefore, minimizes much of the guesswork heretofore required in estimating the porosity correction factor. (auth)

16592 EFFECT OF PLUTONIUM CONTENT ON THE THERMAL CONDUCTIVITY OF $(U,Pu)O_2$ SOLID SOLUTIONS. Gibby, R. L. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. J. Nucl. Mater.; 38: 163-77(Feb 1971).

The thermal conductivities of (U, Pu)O_2 solid solutions containing up to 30 wt % PuO_2 were determined from 100 to 1200°C from measurements of thermal diffusivity. The thermal conductivity data for UO_2 determined from this method were found to be in good agreement with data reported for UO_2 from steady-state measurements. The thermal conductivities of the samples tested could be expressed as a function of temperature by relationships of the form $\lambda = (A + BT)^{-1}$. An increase in the PuO_2 content was observed to result in a small but systematic decrease in the thermal conductivities of the solid solutions. The results of this study are consistent with a simplified theory of lattice defect thermal resistance in dielectric solids in which the uranium and plutonium atoms mutually act as phonon scattering centers. Calculations based on this theory indicate that the thermal conductivity of (U, Pu)O_2 solid solutions is a minimum at approximately 70 wt % PuO_2. (auth)

16593 DIFFUSION AND PRECIPITATION OF HELIUM IN IRRADIATED AND ANNEALED BERYLLIUM OXIDE. Gmelin, E. (Centre de Recherches sur les Tres Basses Temperatures, Grenoble, France). J. Nucl. Mater.; 38: 150-62(Feb 1971). (In French).

With the help of several experimental methods it was shown that it was possible to determine from moment to moment the balance of helium in irradiated and annealed BeO. The specific heat at very low temperatures (near the λ-point of helium) established the mass of helium which had precipitated; chromatography gave the amount of helium desorbed during the anneal and electron microscopy determined the radius and mean separation of helium bubbles in BeO. In this way the process of diffusion and precipitation of helium in BeO was followed accurately. Precipitation of helium began during irradiation; bubble nucleation began from 600°C and peaked at 1200°C. The diffusion coefficient of helium in BeO satisfied the relation: $D = 2.5 \times 10^{-3} \exp(-A/kT)$, where A = 3.45 eV between 1080 and 1400°C. (auth)

16594 STRUCTURE AND WEAR-RESISTANCE OF DENSE ALLOYS OF THE TiC–NICKEL–MOLYBDENUM TYPE. Kabral, Kh. I.; Mozberg, R. K. Tr. Tallin. Politekh. Inst., Ser. A; No. 271, 15-22(1969). (In Russian).

Dense alloys of composition TiC 50 to 83, Ni 9 to 25, Mo 2 to 25% were studied. The difference in structures of various compositions of these alloys was concerned with the relative quantity of the bonding phase (solid solution Ni, Ti, Mo) and the degree of

development of the annular structure around the TiC (from data given by x-ray analysis of the (Ti, Mo)C type complex carbide). The alloys had HRC 90 to 93.5 and a wear resistance that was highest with low angles of attack by the abrasive jet. The greatest wear resistance was given by the composition TiC–9% Ni–9% Mo, i.e., 25 to 51 times greater than that of steel St 3 [C 0.14 to 0.22%]. The wear resistance was lowered by an increase in the quantity of bonding and by an increase in the carbide grain size. Solid alloys of the VK type showed similar phenomena. (Metals Abstr.)

16595 METODY ISSLEDOVANIYA TUGOPLAVKIKH MATERIALOV. (Methods for Studying Refractory Materials). Miloserdin, Yu. V. (ed.). Moscow; Atomizdat (1970). 160p.

New methods and equipment for examining the physical-mechanical properties of materials for use at 3500°K are reviewed. New methods of measuring high-temperature hardness, creep, elastic module, internal friction, and relaxation stability of refractory and metalloceramic materials are described. (tr-auth)

16596 THERMAL STABILITY AND WEAR RESISTANCE OF BORON–TITANIUM METAL DEPOSITS. Kal'yanov, V. N.; Muratov, V. A.; Pocheptsov, A. V. (Zhdanov Metallurgical Inst., USSR). Svar. Proizv.; No. 6, 21-3(Jun 1970). (In Russian).

Results are presented of an investigation of the thermal stability and wear resistance of boron-titanium metal coatings on high-carbon steel plates. The welding procedure for preparing samples and the techniques for measuring the metal hardness and abrasive wear are described. The joint introduction of boron and titanium into a high-carbon metal coating provides a higher thermal stability compared with that of metal separately alloyed by boron and titanium. The thermal and abrasive wear stability of boron-titanium high-carbon metal are not less than those of sormite. The wear resistance to friction on the hot metal is higher than that of 25L and tempered 5KhV2F steels. The laboratory results are confirmed by data from industrial tests. Information on the microstructures of boron-titanium and U15TR metal deposits is presented. (JPRS)

Structure and Phase Studies

Refer also to abstracts 16557, 17284, 18099, 18137, and 18180.

16597 (ANL–7703) OUT-OF-PILE STUDY OF THE EFFECTS OF THERMAL GRADIENTS ON THE DISTRIBUTION OF PLUTONIUM IN FAST-REACTOR FUEL MATERIALS. Chasanov, M. G.; Fischer, D. F. (Argonne National Lab., Ill.). Jul 1970. Contract W-31-109-eng-38. 30p. Dep. NTIS.

Annealing of ceria–urania and plutonia–urania pellets in thermal gradients resulted in apparent increases in cerium and plutonium concentrations at the hotter end of the samples. These results are discussed in terms of various possible mechanisms. Similar experiments on mixed carbide samples indicated that vaporization losses of plutonium from the hotter end, although extensive under some conditions, can be minimized by the use of cladding. (auth)

16598 THEORETICAL STUDY OF THE ENERGIES OF FORMATION OF POINT DEFECTS IN CaF_2 AND UO_2. Tharmalingam, K. (Imperial Coll. of Science and Tech., London). Phil. Mag.; 23: 199-204(Jan 1971).

The Born model of the ionic crystal was used to calculate the energies of formation of point defects in CaF_2 and UO_2 in the zero, first and second orders. The results of calculation, to all orders, indicate that anion-Frenkel pairs are the intrinsic defects in CaF_2 and are in agreement with previous calculations. In UO_2 the zero-order calculation predicts anion-Frenkel pairs as the intrinsic defects, whereas the higher-order calculations indicate that Schottky defects are the intrinsic defects. It is concluded that Schottky defects are the intrinsic defects in UO_2 with an energy of formation of about 7 eV. (auth) (UK)

16599 TRANSMISSION ELECTRON MICROSCOPY OF WC–Co CEMENTED CARBIDES. Hara, Akio; Nishikawa, Takeshi; Nishimoto, Tatsuya. Sumitomo Elec. Tech. Rev.; No. 14, 106-9 (Nov 1970).

Electropolishing of multiphase materials, for example, WC–Co cemented carbides, is a very difficult operation. It is for this reason that very few examples of transmission electron micrographs of the WC–Co cemented carbide were published. In this paper the preparation method of the foil was described and some micrographs are shown. Subgrain boundaries and dislocations were observed in WC phase, and many stacking faults, in the Co phase. (auth)

16600 DISSOCIATION OF VANADIUM OXIDES. Kulikov, I. S. Izv. Akad. Nauk SSSR, Metal.; No. 3, 78-83(May-Jun 1970). (In Russian).

Results of thermodynamic analyses were used to establish the dissociation characteristics of V oxides. The activities of V in oxides were calculated along with gas partial pressures and oxide boiling points. It was found that VO is stable up to 2535°K and V_6O_{13} is stable up to 1570°K. Parameters for VO sublimation and dissociation were found to be different from those reported in the literature. VO_2 was found to be the most stable oxide. A phase diagram of O versus temperature was prepared along with diagrams of gas phases at 1873°K over V oxides. (tr-auth)

16601 PHASE STUDIES OF THE ZrO_2–Nd_2O_3 SYSTEM. Volchenkova, Z. S. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 14, 125-8(1970). (In Russian).

X-ray analyses were used to determine the phases in ZrO_2–Nd_2O_3 after air sintering at 1550°C. The compound $Nd_2Zr_2O_7$ was found which has a pyrochlore structure in solid solution. The compound has pyrochlore structure on the basis of all components, monoclinic and cubic fluorite structure on the basis of zirconium oxide, and is a solid solution on the basis of neodymium oxide (hexagonal and cubic). Phase ratios were examined by measuring the compound total conductivity and that of components. (tr-auth)

16602 DITUNGSTEN CARBIDE OVERLAYER ON W(112). Chen, Jar-mo; Papageorgopoulos, C. A. (Franklin Inst., Swarthmore, Pa.). Surface Sci.; 20: 195-200(Mar 1970).

After initial heating of a W(112) surface, a (10 × 4) structure was observed. This structure was explained by assuming a layer of α–W_2C on the W(112) surface. The crystal was alternately oxidized and heated and LEED patterns of the resulting surface structure were studied. (G.M.C.)

16603 DIVALENT EUROPIUM COMPOUNDS IN THE SYSTEMS Eu–Mo–O AND Eu–W–O. McCarthy, Gregory J. (Pennsylvania State Univ., University Park). Mater. Res. Bull.; 6: 31-9(Jan 1971).

A study was made of compound formation in the systems Eu-Mo-O and Eu-W-O with the objective of preparing the Eu^{2+} analogues of the known Sr^{2+} compounds $EuMoO_4$, $EuWO_4$, and $EuMoO_3$. The scheelite-type compounds $EuMoO_4$ and $EuWO_4$ were easily prepared. No $EuMoO_3$ compound could be prepared over the temperature range 1200 to 1400°C. Three new compounds containing trivalent rare earths were encountered, $Eu_2Mo_2O_7$, $Sm_2Mo_2O_7$, and Eu_6WO_{12}. The first two had cubic pyrochlore-type structures while Eu_6WO_{12} had a defect cubic fluorite structure. The necessity of considering thermodynamic parameters as well as size, charge and polarizability in systematic crystal chemistry is discussed. (auth)

16604 THERMODYNAMICS OF URANIUM–CARBON, URANIUM–NITROGEN AND PLUTONIUM–CARBON SYSTEMS. Akhachinskii, V. V.; Bashlykov, S. N. At. Energ. (USSR); 29: 439-47 (Dec 1970). (In Russian).

The generalized and reviewed published data on thermodynamic properties of the uranium–carbon, uranium–nitrogen, and plutonium–carbon systems are presented. (auth)

16605 STRUCTURAL TRANSFORMATIONS AND DEVIATIONS FROM THE PURE ANION VACANCY MODEL IN LIME ZIRCONIA. Pizzini, S. (CCR–EURATOM, Petten, Netherlands); Wagner, V.; Sanesi, M. Z. Naturforsch.; 25a: 1768-9(Nov 1970).

Small but not negligible deviations from the pure anion vacancy model were observed in pycnometric densities of samples of lime zirconia with a lime content ranging from 10 to 14 mole percent lime. Such deviations are discussed in terms of the subsolidus equilibria occurring within this composition range. (auth)

16606 ABOUT THE SYSTEM MOLYBDENUM–CARBON–NITROGEN. Ettmayer, P. (Technische Hochschule, Vienna). Monatsh. Chem.; 101: 1720-30(Nov-Dec 1970). (In German).

The system Mo–C–N was investigated by nitriding molybdenum–carbon alloys of various compositions at 1100°C with nitrogen of 1, 30, and 300 atm pressure. The nitrided samples were analyzed chemically and investigated by x-rays. Besides the well-known phases of the binary systems Mo–N and Mo–C a phase $Mo_2(C,N)$ with hcp-metal lattice and Mo(C,N) with WC type structure could be observed. At temperatures exceeding 1500°C and high nitrogen pressure (300 atm) a carbonitride with η-Mo_3C_2-structure was found. A tentative phase diagram for 1100°C has been established. (auth)

16607 STUDY OF THE SYSTEMS UN–Mo AND UN–W AT HIGH TEMPERATURES. Politis, C.; Thuemmler, F.; Wede-

meyer, H. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 38: 132–42(Feb 1971). (In German).

Mixtures of uranium mononitride and molybdenum were studied between the temperatures of 2100 and 2700°C. By means of several melt specimens the liquidus line and the eutectic line were determined. Under a pressure of 650 torr nitrogen for the eutectic, a composition of 58 wt % molybdenum and 42 wt % uranium nitride was obtained at a eutectic temperature of 2400 ± 20°C. Particularly in uranium-rich specimens the components of the uranium-rich phase (U_2Mo containing nitrogen) were observed. Additional experiments at higher and lower nitrogen pressures showed displacements of the eutectic composition and temperature. A few special experiments in the analogous system uranium mononitride–tungsten were carried out and the resulting composition for the eutectic, with 96 wt % uranium nitride, was found to lie near the pure uranium nitride. One can suppose that the eutectic melting point is at about 2700°C. (auth)

16608 TlF–ThF_4 SYSTEM. Avignant, Daniel; Cousseins, Jean-Claude (Univ., Clermont-Ferrand, France). Compt. Rend., Ser. C; 271: 1446-8(9 Dec 1970). (In French).

Six compounds in the TlF–ThF_4 system were obtained: Tl_3ThF_7, Tl_2ThF_6, $Tl_7Th_6F_{31}$, $TlThF_5$, $TlTh_3F_{13}$, and $TlTh_6F_{25}$. They were studied by differential thermal analysis and x-ray diffraction. $TlThF_5$ decomposes into $Tl_7Th_6F_{31}$ and $TlTh_3F_{13}$ in the solid state at 519°C. The other compounds lead to a peritectic reaction. $Tl_7Th_6F_{31}$ is rhombohedric and $TlTh_6F_{25}$ hexagonal. (auth) (France)

16609 CRYSTAL STRUCTURE OF THE ThV_2O_7 PHASE. Quarton, Michel; Rimsky, Alexandre; Freundlich, William (Univ., Paris). Compt. Rend., Ser. C; 271: 1439-41(9 Dec 1970). (In French).

The monocrystalline ThV_2O_7 phase obtained for a ThO_2– $2V_2O_5$ mixture by melting at 992°C is orthorhombic and parameters are: a = 7.216 ± 0.004 Å; b = 6.964 ± 0.004 Å; c = 22.80 ± 0.01 Å. The measured density is 5.15 ± 0.04. A Pnnm space group was observed. The structure consists of trigonal bipyramids forming a VO_3 chain parallel to the b direction and of VO_4 tetrahedra. The cohesion of the whole structure is assured by thorium surrounded by eight oxygen atoms. (France)

16610 NEW PHASES OF NIOBIUM NITRIDE. Terao, N. (Union Carbide European Research Associates, Brussels). J. Less-Common Metals; 23: 159-69(Feb 1971).

Two new phases of niobium nitride, Nb_4N_5 and Nb_5N_6, were identified on thin films by electron diffraction. The specimens were prepared by nitriding the evaporated thin films of niobium in ammonia. The structures of these two nitrides were isomorphous with those of Ta_4N_5 and Ta_5N_6, respectively. The Nb_4N_5 phase belonged to the tetragonal system with lattice parameters, $a = 6.87_3$ Å and $c = 4.29_8$ Å, while the Nb_5N_6 phase was based on the hexagonal structure having lattice parameters, $a = 5.19_3$ Å and $c = 10.38_0$ Å. By heating Nb_5N_6 in vacuum at high temperature, successive phase changes were observed: $Nb_5N_6 \rightarrow \delta'$-NbN $\rightarrow$ δ-NbN $\rightarrow$ $Nb_4N_3 \rightarrow Nb_2N$. (auth)

16611 NEODYMIUM–NEODYMIUM HYDRIDE PHASE SYSTEM. Peterson, D. T.; Poskie, T. J.; Straatmann, J. A. (Ames Lab., Iowa). J. Less-Common Metals; 23: 177-83(Feb 1971).

The phase relationships between neodymium and neodymium hydride were established. Hydrogen in solution increased the melting point of neodymium and lowered the $\alpha-\beta$ transformation temperature. A metal-rich intermediate phase was found between 680 and 880°C. The solid immiscibility gap seemed to close above 1150°C. (auth)

16612 FAZOVYI ANALIZ NIKELEVYKH SPLAVOV. (Phase Analysis of Nickel Alloys). Golubtsova, R. B. Moscow; Izdatel'stvo Nauka (1969). 232p.

A systematic exposition of methods used in phase analysis of Ni alloys is presented in which results found in the literature are presented along with results of continued research by individuals. Methods of selecting electrolytes for anodic dissolution of the alloys are described based on their electrochemical behavior and solubility of their solid solutions in chemical media. Emphasis is placed on electrolytic separation of metallographic phases present in Ni alloys based on quantitative analysis of precipitates on the anode. Information concerning phases found in Ni_3Ti, Ni_3Al, Ni_3Nb, $Cr_{23}C_6 \cdot Cr_7C_3$, NbC, TiC, and $Me_{23}(CB)_6$ is included. (tr-auth)

16613 MODELING OF SOLIDUS AND LIQUIDUS CURVES ON ODRA 1003 COMPUTER. APPLICATION TO THE U–Co SYSTEM. Kuchar, L.; Spindlerova, V.; Wozniakova, Blanka Hutn. Listy; 25: 179-85(1970). (In Czech).

Mathematical analysis was made of the solidus and liquidus curves for Co–U and calculations were made of solidus and liquidus as a function of temperature. Phase diagrams are given for Co–U alloys. (R.V.J.)

Radiation Effects

16614 (EURAEC–2146) IRRADIATION OF ZIRCALOY CLAD VIBRATED UO_2–PuO_2 FUEL IN THE BR-2 REACTOR. THERMAL BEHAVIOR AT 800 W/cm. Special Report No. 17. Coquerelle, M. (European Atomic Energy Community, Karlsruhe (West Germany). European Transuranium Inst.); Lhost, A. (Societe Belge pour l'Industrie Nucleaire, Brussels). Jun 1970. 42p. (EUR-4035; BN-7006-07). Dep. NTIS.

Work performed under United States–Euratom Joint Research and Development Program.

Results of dimensional examination showed that very little swelling occurred in the rods during irradiation. Radiography revealed a central void in the otherwise homogeneous rod. Data on gases collected by puncture methods are included along with data on thermal power involved in the tests and data resulting from radiochemical measurements. (J.R.D.)

16615 (GA–10433) RESEARCH ON GRAPHITE. Quarterly Progress Report for the Period Ending November 14, 1970. Engle, G. B.; Price, R. J.; Bokros, J. C. (Gulf General Atomic, Inc., San Diego, Calif.). 24 Nov 1970. Contract AT(04-3)-167. 23p. Dep. NTIS.

A series of previously irradiated graphites and a number of new isotropic materials are under study to determine the effect of crystallite size, crystallite orientation, and density on dimensional and property changes. The new series of isotropic graphites had apparent crystallite sizes ranging from 150 to 850 Å. Preirradiation densities and thermal expansivities were also measured. Scanning electron microscope photographs revealed the shape, size, and surface texture of density fractions in a needle-coke graphite. Experiments to study the temperature-history effects on dimensional changes, the behavior of highly oriented graphites, and the changes in thermal conductivity were continued. Previously irradiated materials are being irradiated to higher fluences, and new materials are also being irradiated. A series of experiments was initiated to study the effect of coke structure on irradiation behavior. Density and x-ray parameters were measured on fine-structured isotropic cokes, heated to 2600 to 2800°C. Specimens have been irradiated in the Dragon reactor to measure irradiation-induced creep in a number of graphites. These specimens are now being measured at RCN, Petten, Holland. Thermal conductivity specimens are also being irradiated. (auth)

16616 RADIATION-ENHANCED DIFFUSION OF BORON IN SILICON. Nelson, Daniel George. Stanford, Calif.; Stanford Univ. (1970). 91p. University Microfilms Order No. 70-22,188. Thesis.

A theoretical and experimental investigation is described of the diffusion of boron in monocrystalline silicon enhanced by bombardment by protons with energies in the 10 to 50 keV range. The substitutional impurity diffusion coefficient was enhanced due to the formation of vacancy-interstitial pairs in excess of the thermal equilibrium concentration by the high energy protons. The diffusion of the vacancies allowed diffusion of substitutional impurity atoms. An expression was derived which allowed calculation of the generation rate of the vacancy-interstitial pairs as a function of the proton flux and energy. This generation rate was then used in the vacancy diffusion-recombination equation to find an expression for the local vacancy concentration in the crystal. Since the impurity diffusion coefficient was proportional to the vacancy concentration, it was spatially dependent and its functional form was the same as the vacancy concentration profile. Using this spatially dependent impurity diffusion coefficient, the impurity diffusion equation may be solved numerically. This allows calculation of impurity concentration profiles as a function of the parameters of the bombardment. When this was done and compared with experimentally measured profiles, it was found that the excess vacancy model was valid for describing radiation-enhanced diffusion. The variation of the radiation-enhanced diffusion rate with proton flux and with temperature is also discussed. Experiments were performed that showed that the impurity diffusion coefficient was independent of temperature in the range of 500 to 700°C. Below 500°C no radiation-enhanced diffusion was observed. It was found that at low proton fluxes the enhanced diffusion coefficient of boron increased linearly with flux, but that at higher fluxes it became independent of it. Mechanisms responsible for this behavior are discussed. The residual damage remaining after the proton bombardment was completed was studied using transmission electron microscopy. It was found that if the bombarded sample was at a temperature below 500°C,

clusters remained in the lattice, but that above 500°C such damage was annealed. Some p-n junction diodes were made using radiation-enhanced diffusion and these were compared to diodes of similar structure made with thermal diffusion. The reverse voltage-current characteristics of these diodes indicated that the junction radii of the diodes made by radiation-enhanced diffusion are much sharper than the junction radii of the thermally diffused diodes. (Diss. Abstr. Int., B)

16617 USE OF THE IMAGE DIFFERENCE METHOD FOR INVESTIGATION OF STRUCTURAL CHANGES OF THIN CARBON FOILS BY ELECTRON IRRADIATION. Langer, R.; Frank, J.; Feltynowski, A.; Hoppe, W. (Max-Planck Institut fuer Eiweiss- und Lederforschung, Munich. Technische Hochschule, Munich). Ber. Bunsenges. Phys. Chem.; 74: 1120-6(Nov 1970). (In German).

Electron microscopical specimens change during their examination in the microscope by contamination, decomposition, and direct radiation damage. Up to now these processes have been investigated as a whole only, for example by measuring the temporal change of the mass-thickness of the specimen or, for crystalline objects, by the relative intensities of the reflexes in the diffraction diagram. Contrary to these methods, the image difference method makes it possible to study alterations in the images of thin objects caused by these processes even to structural details of the microscope's resolution limit. Such alterations in thin amorphous carbon foils and graphite lamellae were determined. Images were registered at various times and after different radiation dosages, the electron optical parameters being constant and the resolution as high as possible. By scanning the micrographs with the spot of an automatic microphotometer, the optical density was represented in digital form. The calculation of the difference image of two images and the reconstruction of the ideal image were done with the aid of an IBM 360/91 computer. (auth)

16618 VISCOELASTIC RESPONSE OF GRAPHITIC MATERIALS IN IRRADIATION ENVIRONMENTS. Chang, T. Y.; Rashid, Y. R. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Eng. Design; 14: 181-90(Nov 1970).

A numerical method is presented for the stress analysis of reactor graphitic components under conditions of plane stress, plane strain, generalized plane strain, or axisymmetry. In the analysis, both the creep deformation and the irradiation-induced strains are the major concern. The mechanical response of the material is assumed to be linear viscoelastic and transversely isotropic. The constitutive relations are formulated in hereditary integral form, and the dependence of the material properties on temperature and neutron flux is considered. To illustrate the method, a numerical example on the analysis of a fuel element is presented. (auth)

16619 COMPARATIVE STUDY OF DEFECT PRODUCTION AND CHANGES IN SURFACE REACTIVITY INDUCED IN OXIDE POWDERS BY HIGH-ENERGY POSITIVELY-CHARGED PARTICLES. Nelson, R. L.; Duck, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 88-100 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd, (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The adsorption of oxygen on magnesium oxide during bombardment with positive ions is due to several damage processes, both at the surface and within the bulk of the solid. The relative efficiencies of bulk vacancy, surface vacancy and ionization in promoting the adsorption of oxygen have been compared. The role of ionization in promoting the adsorption of hydrogen, methane and ethylene on MgO has been studied and mechanisms of charge trapping and charge recombination at the surface have been proposed. The effect of positive ion bombardment on the surface reactivity of thoria, zirconia and zinc oxide is also due largely to ionization processes at low total dose but it has not proved possible to identify the role of displacement-induced lattice defects. (auth) (UK)

Plastics and Other Materials

Refer also to abstracts 15653, 15861, 16412, 16582, and 18171.

16620 (RISO-M-1295) COST EVALUATION OF RADIATION-CURED CONCRETE-POLYMER MATERIALS FOR PIPE MANUFACTURE. Singer, K.; Vinther, A.; Bjergbakke, E. (Danish Atomic Energy Commission, Risoe. Research Establishment); Foerdoes, Z. (Betonforskingslaboratoriet, Karlstrup (Denmark)); Skytte, M. (Betonvarefabriken Sjaelland, Copenhagen (Denmark)); Winther, J. (Pedershaab Machine Works Ltd., Brondersley (Denmark)). Oct 1970. 23p. (CONF-701027-1). Dep. NTIS (U. S. Sales Only).

From Conference on Radiation and Isotope Techniques in Civil Engineering, Brussels, Belgium.

A conceptual design and preliminary cost evaluation were made for the production of radiation-cured plastic impregnated concrete pipes with internal diameters of 30 and 160 cm respectively and a length of 200 cm. The calculation of the ^{60}Co source strength was based on linear absorption of radiation from an infinite rod source using data for mass stopping power and build-up factors as for shielding calculations. The evaluation was only based upon obtainable increase in strength properties, whereas improvement of corrosion resistance was not especially considered. Production costs for plastic-impregnated concrete pipes with strength properties of the same order as those of steel-reinforced pipes or pipes otherwise "refined" were about 50% higher than for these pipes. With a growing market need for corrosion-resistant pipes, e.g., for sewage and industrial waste water, it cannot be excluded that even considering the rather high production costs, the use of plastic-impregnated concrete pipes might become of interest also from an economic point of view in the years to come. (auth) (Denmark)

16621 POLYMER-IMPREGNATED CONCRETE FOR HIGHWAY APPLICATIONS. Pike, R. G. (Bureau of Public Roads, Washington, D. C.). Isotop. Radiat. Technol.; 8: 152-3(1970-71)

The advantages of using polymer-impregnated concretes in highway construction and the preparation and properties of polymer concrete are discussed. (L.C.L.)

16622 DELAYED THERMAL DILATATIONS OF CEMENT PASTE AND CONCRETE DUE TO MASS TRANSPORT. Bazant, Z. P. (Northwestern Univ., Evanston, Ill.). Nucl. Eng. Design; 14: 308-18(Nov 1970).

The delayed thermal dilatation of cement paste and concrete is caused by the diffusion of molecules of water and other species along mono- or multimolecular layers. Applying thermodynamics to this diffusion mechanism, the macroscopic constitutive equation is derived for the case of constant water content. Three different components of thermal dilatation are distinguished: (1) pure thermal dilatation, due to thermal dilatation of constituents; (2) thermal shrinkage or swelling, due to differences in latent heat (and entropy) along the diffusible layers; (3) hygrothermic dilatation, due to a change in relative vapor pressure with temperature at a constant water content. The first two components lead to delayed recovery while the third one results in continued delayed thermal dilatation. The dependence of these components on the water content is discussed. The theory is important for the thermoviscoelastic analysis of prestressed concrete reactor pressure vessels. (auth)

16623 EFFECTS OF GAMMA RADIATION ON ELASTICITY AND CREEP IN ENGELMANN SPRUCE. Shuler, Craig Edward. Fort Collins, Colo.; Colorado State Univ. (1969). 88p. University Microfilms Order No. 70-15,196.

Thesis.

The effect of large doses of γ radiation on the elastic and creep properties of Engelmann spruce was observed by measurement of the dynamic modulus of elasticity before and after irradiation and by description of the creep curves obtained over a two-week loading period. Statistical tests comparing treated specimens to controls indicated significant increases in the dynamic modulus of elasticity for those specimens receiving radiation doses of 10^3, 10^4 and 10^5 rad. A Maxwell–Voigt mechanical model was selected for evaluating the observed creep curves. Specimens were small cantilever beams with concentrated loads. The parameters which were generated according to the mechanical model produced theoretical curves with resulting correlation coefficients of 0.94 to 0.97. Statistical tests on these parameters, however, indicated no significant difference from the controls. The increased modulus of elasticity is apparently the result of additional polymerization or the establishment of crosslinks initiated by the radiation. The creep equation parameters may indicate that this crosslinking occurs in the crystallite region of the cellulose substructure while the nonordered regions of the wood material are more prone to degradation. Evidence of this could not be shown statistically, however. (Diss. Abstr. Int., B)

XUM

PHYSICS (GENERAL)

Astrophysics and Cosmology

Cosmic Ray Exposure Ages

16624 STUDY OF COSMIC DUST. V. ON THE MICROTEKTITES. Yabuki, Sadayo; Okada, Akihiko; Yabuki, Hideo; Shima, Makoto. Rikagaku Kenkyusho Hokoku; 45: 149-55(1969). (In Japanese).

From Collected Papers of the Institute of Physical and Chemical Research, Tokyo, 921-7(1969).

The study of glassy spherules (microtektites), a part of cosmic dust, is reported. Physical and chemical properties of these spherules were examined and compared with those of meteorites and tektites. It is suggested that these spherules are extraterrestrial matter. (Japan)

16625 SODIUM AND MANGANESE HOMOGENEITY IN CHONDRITIC METEORITES. Osborn, T. W.; Schmitt, R. A. (Oregon State Univ., Corvallis). Icarus; 13: 207-14(Sep 1970).

Sodium and manganese were determined via instrumental neutron activation analysis in four to six specimens (each of 0.7 to 1 g), whose original locations were separated by a distance of 5 to 20 cm, in each of 39 large chondritic fragments (>1 kg) representing 29 distinct meteorites. Manganese dispersion for the H-Fe groups ranged from 0.8 to 17%; Na, 1.1 to 31.0%. For the L-Fe groups, Mn dispersions varied from 1.4 to 7.1%; Na, 1.5 to 10.4%. The average dispersion was 4 and 6% for Mn and Na, respectively, for both the H and L-Fe groups. Two E chondrites showed Mn dispersions of 65 and 44% and Na dispersions of 32 and 28%. Examination of abundance dispersions (about ±3% for Na and Mn) in large fragments of obsidian from the Newberry Crater in Central Oregon provides a frame of reference for a homogeneous terrestrial material. Post-fall fractionation, presumably by leaching, may cause dispersions of both Mn and Na to increase by a factor of about 2 for finds compared to falls. The homogeneity observed in meteorites may be inherent to the accretion process. (auth)

Stars

Refer also to abstracts 16780, 16790, and 17580.

16626 (AD-712691) OBSERVATION OF EARLY-TYPE STARS FROM OGO-VI. Clark, Malcolm A.; Metzger, Paul H. (Aerospace Corp., El Segundo, Calif.). 15 Sep 1970. Contract F04701-70-C-0059. 16p. (TR-59(6754)-1; SAMSO-TR-70-363). NTIS.

Stellar fluxes of the order of (10 nanoergs/sec A (cm squared)) for 10-eV photons were observed for several bright ultraviolet-emitting stars. These observations were made from the OGO-VI scanning Lyα experiment whose resonance absorption filter suppressed the strong Lyα airglow, enabling weak external enhancements to be observed. Five separate orbits of data revealed point-source enhancements. Observation with an SrF_2 background light filter established that less than 10% of the observed signals could be at spurious wavelengths. (auth) (USGRDR)

16627 SOLID STARS. Ruderman, Malvin A. Sci. Amer.; 224: No. 2, 24-31(Feb 1971).

The properties of matter at densities from 10^6 to 10^{15} g/cm^3 are discussed. Neutron-star properties are considered in terms of formation, atmosphere, crustal layers, core and central core, seismology, and magnetic fields. (W.D.M.)

16628 FUSION CHAIN REACTIONS IN STELLAR CORES. Smernoff, Barry Jay. Waltham, Mass.; Brandeis Univ. (1970). 80p. University Microfilms Order No. 70-24,659.

Thesis.

The role played by fusion chain reactions in the advanced evolution of stars is studied using a simple method to estimate the multiplication factor k_A for such chain reactions. Knowledge of the stopping power of various stellar media is required, since the specific energy loss of a charged recoil nucleus to its environment is one of the crucial factors determining k_A. After the appropriate dissipative dielectric function was calculated, the Lindhard dielectric formulation of the stopping power problem is used to calculate the energy loss of a test charge to a relativistic degenerate electron gas. The stopping powers of an ion gas and an ion lattice are also calculated, and the collective energy loss to the lattice is expressed as a general function of phonon parameters. A general explosion criterion is derived by finding an upper bound for k_A and it is shown that Gryziński's calculation (Phys. Rev. 115, 1087 (1959)) of ^{3}He chain explosion is erroneous, due to his omission of the ion stopping power. Inclusion of the latter is especially significant for the cases of carbon and oxygen at high densities, and it is shown that at the appropriate electron-capture threshold densities, energy loss of recoil nuclei to the surrounding ion gas is so large that $k_A < 10^{-4}$, precluding the possibility of carbon/oxygen chain explosion at achievable stellar densities. The astrophysical role of fusion chain reactions appears to be limited to the slight enhancement of the usual nuclear reaction rates by the small factor k_A. (Diss. Abstr. Int., B)

16629 CIRCUMSTELLAR DUST MODEL FOR INFRARED STARS. Krishna Swamy, K. S. (Rice Univ., Houston, Tex.). Astrophys. Space Sci.; 9: 123-7(Oct 1970).

The expected thermal emission from the shell around stars was calculated on the graphite model. The calculated spectral distribution was in reasonable agreement with the observed infrared emission from some of the infrared stars. (auth)

16630 ABSOLUTE STELLAR PHOTOMETRY IN THE REGION 1900 TO 3000 A. Campbell, J. W. (Royal Observatory, Edinburgh). Astrophys. Space Sci.; 9: 128-45(Oct 1970).

Twin channel stellar photometers were flown in two sounding rockets in May 1967 and produced a number of absolute photoelectric measurements in the region 2000 to 3000 Å. The observations were made at wavelengths centered on 2150 Å and 2550 Å with passbands of 300 Å on 28 early-type stars in the range of spectral types B0-B9.5 down to a limiting visual magnitude of 4.8. A comparison of the experimental data with other observations and with the theoretically derived fluxes of Mihalas for unblanketed models indicates a satisfactory agreement within the limits of the known photometric accuracies, although there are significant departures for those stars exhibiting emission characteristics and for the magnetic variable α_2 Canum Venaticorum. (auth)

16631 GRAVITATIONAL COLLAPSE OF MAGNETIC NEUTRON STARS. Anderson, James L. (Stevens Inst. of Tech., Hoboken, N. J.); Cohen, Jeffrey M. Astrophys. Space Sci.; 9: 146-52(Oct 1970).

Pulsars are presently believed to be rotating neutron stars with frozen-in magnetic fields. Because of the high density of neutron stars, general relativistic effects are important since they affect both the structure and stability of such stars. Besides this, the magnetic field outside the star is also affected. Instead of falling off as $r^{-(2+1)}$ as in flat space, it is shown that each magnetic multipole varies as a hypergeometric function of radius. A closed form of these hypergeometric functions is given in terms of Legendre functions of the second kind. If the mass of a neutron star exceeds about 2.4 $M_\odot$, the star becomes unstable and collapses. For a quasi-statically collapsing body, it is shown that the magnetic field seen by a distant observer vanishes as the radius approaches the gravitational radius. (auth)

16632 CLUSTER h AND χ PERSEI AND THE PROBLEM OF NEUTRINO EMISSION. Ferrari, A.; Galeotti, P.; Silvestro, G.; Trussoni, E. (Univ., Turin). Astrophys. Space Sci.; 9: 181-4 (Oct 1970).

A change in perspective is reported on the astrophysical test of the existence of direct electron-neutrino coupling through stellar evolution in the red supergiant region. (W.D.M.)

16633 CONVECTIVE ENERGY TRANSPORT IN STELLAR ATMOSPHERES. III. MULTI-STREAM ATMOSPHERES. Ulrich, Roger K. (California Inst. of Tech., Pasadena). Astrophys. Space Sci.; 9: 80-96(Oct 1970).

A theoretical method of computing the temperature structure of hot and cool streams in convective stellar atmospheres is discussed. The method is based on the model that the streams are due to organized cells whose diameters are greater than the thickness of the photosphere. The excess thermal energy of matter rising from the deeper layers, where the entropy is higher than in the photosphere, is converted to radiation in a steady front. This model, applied to the solar case, exhibits a peak-to-peak contrast of 30 to 40% between granules and lanes. This contrast agrees with the Stratoscope data reduced by Namba and Diemel (1969). As a necessary part of the theory, an expression is obtained for the perturbation in radiative heat exchange which may be used in a medium with a strongly preferred direction such as a stellar atmosphere. (auth)

16634 DENSITY DISTRIBUTION, COLOR EXCESS, AND METALLICITY OF K GIANTS AT THE NORTH GALACTIC POLE.

McClure, Robert D. (Yale Univ., New Haven); Crawford, David L. Astron. J.; 76: 31-9(Feb 1971).

Intermediate-band photoelectric observations were obtained of 207 late-type stars near the north galactic pole. The density of K giants at moderate z distances appears to be less than that found by Upgren and is more in agreement with Oort's K_z force law as determined from known mass in the galactic plane. The interstellar reddening at the pole is found to be $E(B-V) = 0.00 \pm 0.01$ m. Although there appears to be large intrinsic scatter, the average metallicity decreases with increasing distance above the galactic plane. One strong cyanogen star was found more than one kiloparsec above the plane. (auth)

16635 WILSON–BAPPU TECHNIQUE APPLIED TO MODERATE-DISPERSION SPECTROGRAMS. Jennings, Mark C. (Kitt Peak National Observatory, Tucson, Ariz. Univ. of Arizona, Tucson); Dyck, H. Melvin. Astron. J.; 76: 40-3(Feb 1971).

A number of stars, first considered by Wilson and Bappu, were reobserved in order to show that useful absolute magnitude information may be obtained from moderate-dispersion spectra for stars of Wilson–Bappu intensity class 2 or greater. (auth)

16636 MULTICOLOR POLARIMETRY OF SOME MIRA VARIABLES. Dyck, H. Melvin (Kitt Peak National Observatory, Tucson, Ariz.); Sandford II, M. T. Astron. J.; 76: 43-9(Feb 1971).

A single-channel polarimeter is described along with the observations of 21 Mira variable stars. It is argued that the four high-galactic-latitude M stars having the best quality data show similar wavelength dependence of polarization. If this conclusion is correct, then the intrinsic polarization for these stars cannot originate in the stellar atmosphere but must arise in a circumstellar envelope. A specific model cannot be selected without further theoretical work. (auth)

16637 PHOTOELECTRIC OBSERVATIONS OF TWO W UMa SYSTEMS. Scarfe, C. D.; Brimacombe, J. (Univ. of Victoria, British Columbia). Astron. J.; 76: 50-1(Feb 1971).

Yellow photoelectric observations of the W UMa systems 44i Bootis and VW Cephei were obtained during the summer of 1969. Times of minima, calculated by the method of Kwee and van Woerden, indicated that 44i Boo has again increased its period after several years of constancy, while VW Cep has shown little change over the past four years. In 1969, the primary and secondary minima of VW Cep were nearly equal in depth. (auth)

16638 PHOTOMETRIC STUDY OF V701 CENTAURI. Chen, Kwan-yu (Univ. of Florida, Gainesville. Cerro Tololo Inter-American Observatory, Arecibo, Puerto Rico). Astron. J.; 76: 52-64(Feb 1971).

Photoelectric observations of the eclipsing variable V701 Cen in the UBV wavelength regions are presented. The intrinsic color indices outside eclipse are $(B-V)_0 = -0.012$ and $(U-B)_0 = -0.280$. Possible solutions based on the Russell model are discussed. Although it was not possible to obtain a perfect fit of the solutions to the observational data, the fit was improved by the addition of "third light" of as much as 39% of the total light of the system. The geometrical effect of a small orbital eccentricity, which seems plausible, is also considered. (auth)

16639 NEW PHOTOELECTRIC INVESTIGATION OF THE ECLIPSING BINARY SYSTEM RR CENTAURI. Chambliss, Carlson R. (Georgetown Coll. Observatory, Washington, D. C.). Astron. J.; 76: 64-72(Feb 1971).

The eclipsing binary RR Centauri was observed photoelectrically in yellow and in blue light at the Cerro Tololo Inter-American Observatory. RR Centauri is a W Ursae Majoris type system with complete eclipses, the primary being a transit. The period of RR Centauri is variable, and the variations in its period are discussed. Solutions are presented which are based on three different methods of rectification. All of these solutions yield comparable orbital elements, which are in good agreement with the orbital elements obtained from previous studies of this system. There is no evidence for orbital eccentricity in RR Centauri. The Fourier coefficients obtained from an analysis of the light outside eclipses are compared with theoretical Fourier coefficients calculated using the adopted orbital elements. The agreement between these is fairly good, when a mass ratio of 1.8 or 1.9 is used in the calculations, but dynamical considerations require a much higher mass ratio for the system. (auth)

16640 MASS RATIOS OF PHOTOGRAPHICALLY UNRESOLVED VISUAL BINARIES. Feierman, Barry H. (Swarthmore Coll., Pa.). Astron. J.; 76: 73-6(Feb 1971).

Observed β values, used to determine the astrometric photocenter, follow the weighted center of light theory for Δm less than 1.0 mag, while for Δm greater than 1.0 mag the observed β values decrease more rapidly than the theory predicts. Due to incorrect values of β, systematic differences appear in the mass ratios determined at Yerkes and Sproul Observatories for five binaries whose Δm is larger than 2.0 mag. The observed β value is less when the binary's linear separation exceeds 0.05 mm on the photographic plate. New mass ratios are calculated for nine binaries based upon the β values found in this investigation. (auth)

16641 EXISTENCE OF OB STARS WITH ANOMALOUS NITROGEN AND CARBON SPECTRA. Walborn, Nolan R. (Univ. of Chicago). Astrophys. J.; 164: L67-9(1 Mar 1971).

It has been found that there are absorption-line OB spectra showing nitrogen–carbon anomalies analogous to those among the Wolf–Rayet stars. A new spectral-classification notation is proposed for these stars, and several examples are briefly described. (auth)

16642 STARS HAVING STRONG O VI EMISSION. Sanduleak, N. (Case Western Reserve Univ., Cleveland). Astrophys. J.; 164: L71-2(1 Mar 1971).

Twelve stars that show the O VI doublet λλ3811, 3834 strongly in emission are nuclei of planetary nebulae. Five other stars (one newly discovered) also show this emission but do not appear to be planetary nuclei. The physical relationship between the two groups is discussed. (auth)

16643 ISOTOPE STRUCTURE OF THE Hg II LINE λ3984 IN THE SPECTRUM OF IOTA CORONAE BOREALIS. Preston, George W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 164: L41-2(1 Mar 1971).

Isotopic components of Hg II λ3984 were resolved in the spectrum of ι CrB. Isotopic abundances derived from these components differ from those for the Earth and two other Hg stars. (auth)

16644 CARBON MONOXIDE IN THE INTERSTELLAR SPECTRUM OF ZETA OPHIUCHI. Smith, Andrew M.; Stecher, Theodore P. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 164: L43-7(1 Mar 1971).

Carbon monoxide has been detected in the interstellar absorption spectrum of ζ Ophiuchi. Equivalent widths are presented for eight transitions in the $(A\ ^1\Pi - X\ ^1\Sigma^+)$ fourth positive system of $^{12}C^{16}O$ and for four of $^{13}C^{16}O$. A satisfactory fit to a curve of growth can be obtained only when the rotational states are assumed populated by the universal blackbody radiation. A column density of 7.6×10^{15} molecules cm^{-2} for $^{12}C^{16}O$ and of 0.072×10^{15} molecules cm^{-2} for $^{13}C^{16}O$ is found, which yields a $^{12}C/^{13}C$ ratio of 105. The column density of atomic hydrogen is 4.6×10^{20} atoms cm^{-2}, in agreement with the value previously reported. (auth)

16645 MODEL ATMOSPHERE ANALYSIS OF THE BINARY 112 HERCULIS. Seligman, Courtney E.; Aller, L. H. (Univ. of California, Los Angeles). Astrophys. Space Sci.; 9: 461-81(Dec 1970).

Double-lined spectra were obtained at 2 Å/mm for the Mn star 112 Herculis AB. The components are shown to be a B6.5V star and A2V star. Hydrogen-line-blanketed models were used to calculate atmospheric abundances. The best models appear to be $T_e = 13500$K, log g = 4.0, $\xi_T = 2.5$ km/sec for the primary; and $T_e = 10{,}000$K, log g = 4.2, $\xi_T = 6$ km/sec for the secondary. Both stars appear to have the same abundances. Helium, carbon, magnesium, aluminum, silicon, calcium, vanadium, and nickel appear to be considerably underabundant; phosphorus, scandium, titanium, manganese, iron, gallium, and mercury considerably overabundant; and chromium, strontium, and zirconium normal in abundance. (auth)

16646 GRAVITY DARKENING OF THE SECONDARY COMPONENT OF ALGOL. Budding, Edwin; Kopal, Zdenek (Univ. of Manchester, Eng.). Astrophys. Space Sci.; 9: 343-52(Dec 1970).

An analysis of the infrared light curve of the secondary minimum of the Algol system—when the contact subgiant component of spectral class K0 undergoes eclipse by its nearly spherical and early-type mate—for the gravity-darkening of the distorted contact star has disclosed that the monochromatic coefficient τ_λ of this darkening at $\lambda = 1.6\ \mu$ is some three to four times larger than that resulting from von Zeipel's theory. This is in agreement with recent photometric studies of gravity darkening in WUMa-type systems, but in flagrant contrast with the consequences of theories requiring deep subsurface convection zones for subgiants of advanced spectral types. The origin of this discrepancy remains unresolved, and underlines the need of further observations of the secondary minima in semidetached eclipsing systems in the infrared. (auth)

16647 OPTICAL SURFACE FEATURES AND MORPHOLOGIC PROPERTIES OF THE ORION NEBULA. Wurm, Karl; Perinotto, Mario (Asiago Astrophysical Observatory, Italy). Astrophys. Space Sci.; 9: 383-97(Dec 1970).

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In the field parts H, K, L, and M of the Orion Nebula, no obvious differences appear in the monochromatic photographs obtained in Hα + [NII], [OII], the visual continuum, and the range of the Balmer continuum. A different situation is met in the rest of the field where one observes two types of features A and B. Relative to the conditions in the Hα + [NII] pictures, the type A areas gain in intensity in the photographs taken in the visual continuum. The emission in the forbidden [OII] lines at λ3727Å is correlated with Hα + [NII], the emission in the range of the Balmer continuum with the visual continuum. According to these properties, the A areas must have a particularly high percentage of scattered star light. Most of the areas with identical monochromatic features show a high deficiency of cluster stars correlated with a low surface brightness and a reduced gas density. This is explained by an opaqueness of the emission strata in the direction in the line of sight and a position of the same nearer to the observer than the extension of the cluster. Surface structures appear at large distances from the Trapezium that show a correlation between the intensity of scattered star light and the intensity of the emission of the higher ions ([OIII], [NeIII]). This observation is considered as a proof that "canals" through the nebular cloud complex allow, in some directions, the exciting radiation to reach large distances from the star without having suffered an appreciable absorption or scattering. (auth)

16648 ASYMPTOTIC NATURE OF CLAIRAUT THEORY. Lebovitz, N. R. (Univ. of Chicago). Astrophys. Space Sci.; 9: 398-409(Dec 1970).

An elementary method is described for justifying the perturbation theory that provides the structure of a slowly rotating, self-gravitating mass in terms of the structure of a corresponding nonrotating configuration (Clairaut Theory). The main point of the method is the adoption of the viewpoint that the density, rather than the angular velocity, be prescribed as a function of position, since this leads to a completely elementary existence theory of rotating, self-gravitating masses. The method is carried out for the case of constant angular velocity, verifying the asymptotic nature of both the classical Clairaut Theory and more general theories (including Chandrasekhar's theory of distorted polytropes) that are in use in astrophysics. (auth)

16649 SPECTRAL EVOLUTION OF NOVA DELPHINI 1967 IN THE NEAR INFRARED IN 1969. Andrillat, Yvette (Faculte des Sciences, Montpellier, France); Houziaux, Leo. Astrophys. Space Sci.; 9: 410-17(Dec 1970). (In French).

Spectra of Nova Del 1967 were obtained in the photographic infrared during the period March to November 1969. The gradient in the region 1.3 to 1.7 μ^{-1} decreased from 3.06 in November 1968 to 2.57 in November 1969. The main spectral features occurring in the wavelength range 5800 to 9600Å are described, while the profiles of some strong lines are displayed. (auth)

16650 STELLAR ATMOSPHERES MODELS OF K-GIANT STARS: THE INFLUENCE OF OPACITY SOURCES. Natta, Antonella; Preite-Martinez, Andrea (Laboratorio di Astrofisica, Frascati, Italy). Astrophys. Space Sci.; 9: 440-52(Dec 1970).

Four different models for a K-giant atmosphere (T_e = 4500K, log g = 2) were computed. Each model is characterized by the inclusion of different opacity sources [H, H^-, σ(H), metals, blanketing effect, He^-] in order to obtain an evaluation of the model sensitivity concerning the atmospheric structure and the emergent flux. Results show that hydrogen, metals, and the blanketing effect must be taken into account to achieve self-consistent and reliable models. A picture of the influence of the frequency distribution of the absorption coefficient on the model features is also shown. (auth)

16651 INFRARED STUDIES OF GALACTIC NEBULAE. II. B STARS ASSOCIATED WITH NEBULOSITY. Gillett, F. C. (Univ. of California, San Diego, La Jolla); Stein, W. A. Astrophys. J.; 164: 77-82(15 Feb 1971).

Several hot stars that are known to be associated with nebulosity were observed at λ = 3.5, 4.9, 8.4, and 11.0 μ. In the case of some of these objects (Z CMa, BD 40° 4124) most of the energy occurs at infrared wavelengths, thus requiring a value greater than one for absorption optical depths in dust at visual wavelengths. The smaller amount of infrared energy observed in the case of other objects (e.g., AB Aur, HD 200775) implies optical depths in dust surrounding the stars that are less than one. The radiating particles must be quite close to the stars (10^{13} to 10^{14} cm) to be observed at these wavelengths. The possible history and physical environment of the dust near these stars are discussed. (auth)

16652 OBSERVATIONS OF INFRARED RADIATION FROM COOL STARS. Gillett, F. C. (Univ. of California, La Jolla, San Diego); Merrill, K.-M.; Stein, W. A. Astrophys. J.; 164: 83-90 (15 Feb 1971).

Four-color infrared photometry at 3.5, 4.9, 8.4, and 11.0 μ was carried out on more than 100 cool carbon stars, S stars, and M stars. The data show excess infrared emission from most of these objects. The largest excesses at λ = 11 μ occur for M supergiants. The photometric data indicate that the spectra of radiation from solid particles radiating in the atmospheres of carbon stars are different from the spectra of radiation from particles radiating in the atmospheres of M stars. It is suggested that this difference is due to differences in the chemical composition of solid particles between carbon-rich stars (probably graphite) and M stars (probably silicates). Molecular absorptions in the 3-μ region (probably due to H_2O, HCN, or C_2H_2) and in the 5-μ region (probably due to CO or CN) were also observed in several of the stars. The shape of the observed photometric spectra in the 3- to 5-μ range is dependent on variability class. (auth)

16653 TRANSFER OF RADIATION IN CIRCUMSTELLAR DUST ENVELOPES. III. THE CASE OF DISTANT ENVELOPES. Huang, Su-shu (Northwestern Univ., Evanston, Ill.). Astrophys. J.; 164: 91-6(15 Feb 1971).

A study was made not only of the continuous conversion of optical to infrared radiation but also the continuous conversion of directional flow of stellar radiation to the diffused radiation fields. Such a case exists when the envelope is far away from the star, in contradistinction to the case discussed in a previous paper in which the envelope was assumed to be close to the star. In order to formulate the present problem in a mathematically manageable form, it was assumed that the central star as seen by any point in the envelope appears as a point source. The two ways of approximating the problem—one discussed in the previous paper and the other presented here—do not give greatly different results as far as the infrared radiation field and the temperature distribution in the envelope are concerned if everything else remains the same. However, the nature of the optical radiation field is quite different in the two cases. (auth)

16654 NONCONSERVATIVE EQUATION OF TRANSFER FOR A COMBINATION OF RAYLEIGH AND ISOTROPIC SCATTERING. Bond, G. R.; Siewert, C. E. (North Carolina State Univ., Raleigh). Astrophys. J.; 164: 97-110(15 Feb 1971).

The developed numerical results for the pertinent H-matrix are used to evaluate semi-analytical solutions to the albedo and Milne problems in context of the vector equation of transfer appropriate to a nonconservative mixture of Rayleigh- and isotropic-scattering laws. In addition to a tabulation of the H-matrix for representative values of the considered parameters, computed results for the half-space albedo and the extrapolated endpoint, the laws of darkening, and the degree of polarization for the Milne problem are reported. (auth)

16655 LITHIUM AND THE s-PROCESS IN RED-GIANT STARS. Cameron, A. G. W. (Yeshiva Univ., New York. Goddard Space Flight Center, New York); Fowler, W. A. Astrophys. J.; 164: 111-14(15 Feb 1971).

Some consequences are discussed of the possibility that helium-burning shell flashes in advanced stages of stellar evolution occasionally induce complete convection of the outer envelope down to the helium-burning shell. If the hydrogen mixing is relatively small for the first 10^7 seconds, the result may be the production of large amounts of heavy elements by the s-process. When complete mixing commences, the ^3He in the envelope will be converted to ^7Be, and the subsequent delayed electron capture to form ^7Li may allow enough lithium to remain near the surface to account for the very large lithium abundances in some S and carbon red-giant stars. On this basis the $^7Li/^6Li$ ratio in these stars should be quite large (>100). (auth)

16656 TERMINATION OF SHELL BURNING OF HELIUM IN SOLAR-MASS STARS. Kutter, G. S. (Univ. of Virginia, Charlottesville). Astrophys. J.; 164: 115-24(15 Feb 1971).

The evolution of a $1.04M_\odot$ star, composed initially of a $1M_\odot$ ^{12}C core and a $0.04M_\odot$ ^4He-rich envelope, is followed through the terminal phase of ^4He shell burning to the white-dwarf stage. During the phase of maximum ^4He burning, the photon luminosity ($\approx 10^{4.8}$ $L_\odot$) exceeds by a factor of ~2 the critical luminosity above which mass loss occurs by momentum transfer from the radiation to the gas. This represents a possible mechanism for the ejection of planetary nebulae from highly evolved stars in the approximate range 1.0 to 1.4 $M_\odot$. Qualitative agreement with the observational data of the precursor stars and the nuclei of planetary nebulae tends to support this connection. Helium shell burning is extinguished when the time scale of photon diffusion from the shell source to the surface becomes of the order of the time scale of nuclear energy production, $u/\{\epsilon[3\alpha] + \epsilon[^{12}C(\alpha,\gamma)^{16}O]\}$: the shell source loses energy more rapidly than it can replenish by nuclear burning and contraction. No thermal instabilities were found, probably because of the large contribution of radiation to

the equation of state in and above the shell source ($0.30 \lesssim \beta \lesssim 0.65$). (auth)

16657 EXAMINATION OF THE CRITERION FOR THE LOWER MASS LIMIT TO THE MAIN SEQUENCE. Straka, W. C. (Univ. of California, Los Angeles). Astrophys. J.; 164: 125-30(15 Feb 1971).

Several criteria for the critical mass for a main-sequence star are examined. It is shown that the maximum rate of nuclear-energy generation comes after the maximum central temperature is reached in a contracting low-mass polytrope, the falloff of the central temperature being due to degeneracy effects. Furthermore, the main-sequence configuration for objects of very low mass is reached after the rate of energy generation begins to decrease. Thus a detailed study of the structure of low-mass stars is necessary for an accurate determination of the critical mass. Furthermore, it is shown that the lines of limiting radii for white dwarfs lie close to or above the lower end of the main sequence in the color–magnitude diagram for masses below the critical mass, and should thus provide a possible observational test. (auth)

16658 COMPUTER SOLUTION OF THE LIGHT CURVES OF S CANCRI. Linnell, Albert P.; Proctor, Deanne D. (Michigan State Univ., East Lansing). Astrophys. J.; 164: 131-6(15 Feb 1971).

A solution of the S Cnc light curves by Huffer and Collins was completed with Kopal's iterative method including a differential correction term for the limb-darkening coefficient of the occulted star. The method applies to total eclipses (occultation) or annular eclipses. The results were checked by a separate program of general differential corrections applied directly to the system parameters. The resulting values of x_1, derived from UBV observations, are in serious disagreement with theoretical values due to Grygar. Separate tests of the method of solution with synthetic data show that values of x_1 can be determined with acceptable accuracy, given the number and apparent precision of observations entering the solution. There are indications of systematic errors in the observations which may invalidate the calculated limb-darkening coefficients. (auth)

16659 PROBLEMY ZVEZDNOI EVOLYUTSII I PEREMENNYE ZVEZDY. ASTRONOMICHESKOGO SOVETA AN SSSR SIMPOZIUMA, S 24 PO 27 NOYABRYA 1964 g. V MOSKVE. (Problems of Stellar Evolution and Variable Stars. Astronomical Society of the USSR Academy of Sciences Symposium, 24–27 November 1964, Moscow). Kopylov, I. M. (ed.). Moscow; Izdatel'stvo Nauka (1968). 164p. (CONF-641139).

Twenty-nine papers presented at the 1964 symposium were corrected and supplemented by more current data. Aspects of the origin and development of stars and galaxies and the role of variable stars in the evolutionary process are analyzed. (R.V.J.)

16660 ROTATING STAR MODELS IN NONRELATIVISTIC GRAVITATIONAL THEORY. Papoyan, V. V.; Sedrakyan, D. M.; Chubaryan, E. V. (Erevan State Univ.). Dokl. Akad. Nauk Arm. SSR; 49: 237-41(1969). (In Russian).

A set of equations containing two independent parameters of the central density and angular velocity are presented as determining the structure of an equilibrium pseudospheroidal configuration rotating as a solid body. The temperature is a function only of the density. The maximum angular velocity is determined by the condition that matter does not flow from the equator. Thus with a fixed central density a succession of equilibrium models is obtained with increasing momentum. Exact methods of solving the problem do not exist. If it is assumed that the perturbations caused by the rotation are small, it is possible to obtain the structure and integral characteristics of white dwarfs and neutron stars. The solution of the equations is sought in the form of Legendre polynomials. Expressions are obtained for the gravitational potential within and outside of the distribution of masses. The radius of the configuration is also given. (TTT)

16661 SIMPLE GASDYNAMICAL MODEL OF MASS EXCHANGE IN CLOSE BINARY SYSTEMS. Biermann, Peter (Univ., Goettingen, Netherlands). Astron. Astrophys.; 10: 205-12(Jan 1971).

A simple gasdynamical model of the mass exchange in close binaries is presented. The assumption of supersonic flow makes it possible to use the method of characteristics for the numerical computation. The results show that the gas is flowing from the inner Lagrangian point to the following hemisphere (i.e. in the sense of the orbital revolution) of the companion in all computed cases. (auth)

16662 SUPERNOVA REMNANT W 28. Milne, D. K. (CSIRO, Sydney); Wilson, T. L. Astron. Astrophys.; 10: 220-7(Jan 1971).

The 5000-MHz brightness distribution, 5000- and 2700-MHz polarization, and H109α recombination line observations are presented for the supernova remnant W 28. The distribution of the spectral index between 408 and 5000 MHz with high-resolution clearly shows the presence of both thermal and nonthermal components in W 28. This is also demonstrated by the observations of both the recombination line and polarization. The magnetic field derived from the polarization observations is thought to be tangential over most of the shell. (auth)

16663 INSTABILITIES IN THE ENVELOPE OF THE Be STAR HD 37202 ζ TAU. Delplace, A. M. (Observatoire, Meudon, France). Astron. Astrophys.; 10: 246-56(Jan 1971). (In French).

As ζ Tau is a binary system (P = 132.91d), an attempt was made to find if the secondary component might bring some changes in the primary spectrum. Specially, an attempt was made to explain the observed irregularities in the radial velocity curve of 132.91-d period which is superimposed on the 7-year pseudoperiod relative to the oscillation of the envelope. (W.D.M.)

16664 FEAUTRIER-TYPE METHOD FOR MODEL ATMOSPHERES INCLUDING CONVECTION. Gustafsson, Bengt (NORDITA, Copenhagen). Astron. Astrophys.; 10: 187-92(Jan 1971).

A Feautrier-type computing scheme was constructed for model atmospheres in which both convection and radiation contribute to the energy transport. Several test computations prove that the method is rapidly convergent and quite automatic for stars within a large region in the H–R diagram. The additional numerical errors introduced by the generalization of the radiative equilibrium case are found to be of little importance. (auth)

16665 MORPHOLOGICAL CLASSIFICATION OF SYMMETRICAL NEBULAE. Greig, W. E. (Univ. of Illinois, Urbana). Astron. Astrophys.; 10: 161-74(Jan 1971).

So-called planetary nebulae are divided morphologically into two major classes B and C and also into two smaller classes A and E. The system herein is the optimal one because it correlates with observed physical quantities and is the only morphological system to do so, is based on overall geometrical features and three-dimensional geometrical models, is based on symmetry considerations, contains the minimum number of classes i.e., two, and minimizes the number of nebulae not fitting the system. Furthermore it is a mnemonic system allowing quick learning and application of the terminology. Class C nebulae have a centric increase in surface brightness. Class B nebulae must have large ansae or large "tubular" or filamentary structures. Class E nebulae are egg-shaped and class A nebulae are spherical annuli because of their very dark centers. Specifically B nebulae have strong forbidden N II, O II, and O I relative to the Balmer lines whereas for C nebulae these ratios are decidedly smaller. By extension these ratios can supplement or even determine the class where the morphology is uncertain or indeterminate. The two main classes are divided into several archetypes. The way in which these archetypes overlap lends credence to the unity of each class. The evolutionary track of Seaton (1966) is modified to show the separate tracks of B and C nebulae. The nuclei of young B's are WC stars in contradistinction to young C nuclei which are almost always WN and/or Of stars. At least some E nuclei are A0 or P Cyg stars. Due to the high degree of symmetry found in, without exception, all recognized planetaries, the name symmetrical nebulae is suggested. (auth)

16666 LUMINOSITIES, MASSES, AND PERIODICITIES OF MASSIVE RED SUPERGIANTS. Stothers, R.; Leung, K. C. (Goddard Inst. for Space Studies, New York). Astron. Astrophys.; 10: 290-300(Jan 1971).

Luminosities and masses of M-type supergiants belonging to extreme Population I were derived from (a) cluster membership and other strictly empirical luminosity and mass criteria and (b) the pulsational Q value method applied to the known variables. New periods for eight variables were determined from AAVSO data. It is found, in general, that the primary period and the long secondary period both increase with brighter luminosity class and later spectral type. This reflects, partly, the increase of mass with increasing luminosity if the primary period is interpreted as being due to the fundamental mode of radial pulsation and if the appropriate theoretical mass–luminosity relation is adopted. The long secondary period is tentatively interpreted as the convective turnover time of giant convection cells in the stellar envelope. A possible alternative interpretation is that the primary and secondary periods represent, respectively, the first overtone and the fundamental mode of radial pulsation. Luminosities based on methods (a) and (b) are in good agreement, and yield a self-consistent calibration of the mean absolute visual magnitudes of the different luminosity classes. The pulsational masses of variables in associations are in satisfactory agreement with the

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masses inferred from the main-sequence turnoffs, thereby implying that little mass has been lost. The evidence is very strong that the majority of red supergiants are in the early stages of core helium burning. (auth)

16667 SPECTRAL TYPES OF BRIGHT STARS IN STELLAR RING NO. 373. Haug, U.; Kohoutek, L. (Hamburg Observatory). Astron. Astrophys.; 10: 319-20(Jan 1971).

Spectral types of 12 stars in and near "stellar ring No. 373," obtained from objective prism plates, contradict the interpretation of photometric data given by Isserstedt and Schmidt-Kaler. As a consequence, the reddening E_{B-V} in this direction is between 0.2m and 0.6m and not 1.0m. The bright stars in the ring have probable distances between 150 and 1420 pc, forming no physical configuration. (auth)

16668 MEMBERSHIP OF THE YOUNG OPEN CLUSTER NGC 6823. Erickson, R. R. (Yerkes Observatory, Williams Bay, Wis.). Astron. Astrophys.; 10: 270-7(Jan 1971).

Relative proper motions with a mean error of ±0.008"/yr were determined for 146 stars in the region of the open cluster NGC 6823, using two pairs of plates taken with the Yerkes Observatory 40-inch (102-cm) refractor. These motions were used to compute probabilities of cluster membership for the 92 stars brighter than visual magnitude 13.0. The 41 stars with probabilities larger than 48% were individually dereddened by the "Q-method" of Johnson. A definitive ratio of total-to-selective absorption could not be determined; ratios between 3.0 and 5.0 fit the data about equally well. The overall features of the color-magnitude diagram are little affected by the ratio used, and generally the diagram resembles those of NGC 2362 and h and χ Persei. However, the average excess in B − V is about 0.9 magnitudes, making the distance modulus rather sensitive to the ratio chosen; the distance varies between 1100 and 2500 parsecs for ratios between 5.0 and 3.0. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 16726 and 17328.

16669 FEW REMARKS ON GAMMA RADIATION AND THE CHEMICAL COMPOSITION OF QUASARS. Ginzburg, V. L.; Ozernoi, L. M. (Lebedev Inst. of Physics, Moscow). Astrophys. Space Sci.; 9: 109-22(Oct 1970). (In English and Russian).

It is shown that, by sufficiently high-power γ radiation, (in particular, that of γ-ray Compton effect origin) photonuclear reactions can substantially alter the chemical abundance of material in the central region of the quasars. The absence of observed distortion of the chemical composition of the emitting regions of quasars constitutes evidence for the effective mixing of plasma in central regions of the quasars, and/or for the diminishing Compton loss on account of the radial magnetic fields. (auth)

16670 X-RAY SOURCES AND THE DIFFUSE BACKGROUND. Setti, G.; Woltjer, L. (Columbia Univ., New York). Astrophys. Space Sci.; 9: 185-92(Oct 1970).

Possible numbers of x-ray sources at various flux levels are considered and their contribution to the background evaluated. Conclusions are: The mean spectrum of quasi-stellar objects and the nuclei of Seyfert galaxies between optical and x-ray wavelengths is characterized by a spectral index well in excess of 1.0. These objects may make an important contribution to the soft x-ray background. Observations of quasars may allow a decisive test for the cosmological interpretation of the redshifts of the quasars. With regard to galactic sources it is found that few undetected sources of the Sgr-Sco type exist, that these sources are located in the immediate neighborhood of the galactic center, and that they account for at least 80% of the total galactic source luminosity. However, many intrinsically much fainter galactic sources may exist. (auth)

16671 ABSORPTION-LINE SPECTRUM OF 4C 05.34. Lynds, Roger (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 164: L73-8(1 Mar 1971).

The absorption lines in the spectrum of the large-redshift QSO 4C 05.34 are reported, and a preliminary analysis is presented. Evidence is found for five separate absorption-line redshifts, all of which are less than the emission-line value. The distribution of absorption lines is striking in that essentially all unidentified lines are located on the short-wavelength side of the Lα emission line. A probable explanation of this effect is discussed. (auth)

16672 POSITIONS OF 352 SMALL-DIAMETER RADIO SOURCES. Fomalont, E. B.; Moffet, A. T. (California Inst. of Tech., Pasadena). Astron. J.; 76: 5-11(Feb 1971).

Positions, 1425-MHz flux densities, and diameters or diameter limits are given for 352 small-diameter radio sources. The positions have estimated rms errors of about 2.5 sec of arc. The majority of the sources have angular diameters of less than 30 sec of arc in both the east-west and north-south directions. (auth)

16673 SHORT-TIME-SCALE VARIABILITY IN QSO's. Angione, Ronald J. (Univ. of Texas, Austin). Astron. J.; 76: 25-30(Feb 1971).

Photoelectric observations of selected QSO's were made in an effort to study very short time-scale variations. Monitoring of 3C 273 with a time scale of 2 hours to 2 minutes yielded no significant rapid changes. However, monitoring of 3C 454.3 showed variations with a time scale of hours (0.3 mag/hour). In addition, a suggestion of possible correlation between optical and radio variations in 3C 454.3 was found. (auth)

16674 OBSERVATION OF 140-GHz FORMALDEHYDE LINE EMISSION FROM THE TRAPEZIUM REGION OF THE ORION NEBULA. Kutner, M. (Columbia Univ., New York. Goddard Inst. for Space Studies, New York); Thaddeus, P.; Jefferts, K. B.; Penzias, A. A.; Wilson, R. W. Astrophys. J.; 164: L49-54 (1 Mar 1971).

Line emission from the direction of the OH source in Ori A was detected which was attributed to the 140.8393-GHz, $1_{11}-2_{12}$ rotational transition of formaldehyde. The radial velocity of the line was +10 km sec^{-1}, and its peak brightness temperature was about 10°K; the emission extends over an area about 3' in diameter. It is argued that to have escaped detection at 4.83 GHz the observed H_2CO must lie behind the Trapezium and continuum source Ori A. The total mass of the cloud was estimated to be >10 $M_\odot$. The line was not found in a number of other galactic H II regions, or in dark nebulae. (auth)

16675 X-RAY SPECTRA OF THE CRAB NEBULA AND NP 0532. Fritz, Gilbert (Naval Research Lab., Washington, D. C.); Meekins, John F.; Chubb, Talbot A.; Friedman, H.; Henry, Richard C. Astrophys. J.; 164: L55-60(1 Mar 1971).

The x-ray pulsar in the Crab Nebula, integrated over the energy range 0.5 to 9 keV, has a primary-pulse profile slightly narrower than that of its optical counterpart. The pulsed fraction of the total x-ray emission varies smoothly from about 2% near 1 keV to about 10% at 7 keV, corresponding to a pulsar spectral index of -0.2 ± 0.1 for the energy flux. If this fraction is constant at 15% above 15 keV, then a break in the slope of the pulsar spectrum must occur near 10 keV. The apparent interstellar absorption of soft x rays from the Crab Nebula implies 0.55 ± 0.10 hydrogen atoms cm^{-3} between us and the Crab. This is twice the density indicated by 21-cm absorption measurements, but the difference may be due to x-ray absorption by interstellar grains. (auth)

16676 SIMULTANEOUS RADIO AND OPTICAL MEASUREMENTS OF SCORPIUS XR-1. Lampton, Michael; Bowyer, Stuart; Welch, Jack; Grasdalen, Gary (Univ. of California, Berkeley). Astrophys. J.; 164: L61-5(1 Mar 1971).

Radio measurements of Sco XR-1 were undertaken to verify the reported variability of this object at radio frequencies. Optical measurements were made simultaneously to search for covariability between the optical and radio flux. During the observing period, the optical output of the object varied but did not flare, while the radio emission varied on a time scale of hours to days. No correlation was evident between variations in these fluxes. (auth)

16677 ACCELERATION OF CHARGED PARTICLES IN A VARIABLE MAGNETIC FIELD. Bakhareva, M. F.; Lomonosov, V. N.; Tverskoi, B. A. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 59: 2003-15(Dec 1970). (In Russian).

It is shown that acceleration of particles in a homogeneous magnetic time-periodic field (Alfvén magnetic pumping) reduces to particle diffusion in momentum space; the relation between the diffusion coefficient and turbulence spectrum dh^2/dk (k is the wave number) is established. The self-consistent problem regarding the wave and particle spectrum is formulated and solved, and it is found that $dh^2/dk \sim k^{-2}$. It follows from the solutions that if magnetic bremsstrahlung radiation is taken into account, the diffusion coefficient D_0 for ultrarelativistic electrons will not differ from the Fermi value. An expression is obtained for the minimal concentration of accelerated particles for which cyclotron instability ensures the scattering required for efficient acceleration. It is demonstrated that the effect is sufficient for generation of electrons yielding the observed x-ray synchrotron emission from the Crab nebula and the pulsar located in the middle of the nebula. Numerical estimates of D_0 and x-ray electron concentration are presented. (auth)

16678 DYNAMICS OF HYDROMAGNETIC BUBBLES AND DOUBLE RADIO SOURCES. Levy, Eugene H. (Univ. of Chicago). Astrophys. J.; 164: 23-7(15 Feb 1971).

The dynamics of a bubble of highly energetic charged particles embedded in the interstellar or intergalactic magnetic field and in gas is discussed. It is shown that the bubble splits, with its two components propagating away from one another in opposite directions along the locally uniform magnetic field. The suggestion is made that synchrotron radiation from the boundaries of such bubbles may be observed as double radio sources. (auth)

16679 H I SPECTRAL-LINE OBSERVATIONS IN THE DIRECTION OF W31. Riegel, Kurt W. (Univ. of California, Los Angeles). Astrophys. J.; 164: 29-45(15 Feb 1971).

Contour maps of antenna temperature in the region of W31 are presented. H I absorption features occur at radial velocities of +6.5, +16.5, and +27 km sec^{-1} with respect to the local standard of rest. Neither of the two possible kinematic distances is likely to be correct. The true distance of W31 is probably about 4.5 kpc, although noncircular motions may be responsible for a distance error. H I absorption is probably associated with H109α emission and OH absorption, but is probably unrelated to H_2CO absorption. (auth)

16680 RADIO RECOMBINATION LINES AND NON-LTE THEORY: A REANALYSIS. Hjellming, R. M.; Gordon, M. A. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 164: 47-60(15 Feb 1971).

A graphical method of obtaining non-LTE solutions of data on radio recombination lines for the Orion Nebula and M17 shows the dependence upon different calculations of the non-LTE populations (b_n-factors). Temperature solutions are found to be independent of differences in b_n-factors. Although these differences do affect the solutions for the electron concentration and the emission measure, the fact that high values of the emission measure are always obtained indicates that most of the radiation must come from very dense emitting regions embedded in the nebulae. (auth)

16681 SOFT X RAYS FROM TWO SUPERNOVA REMNANTS. Palmieri, T. M.; Burginyon, G.; Grader, R. J.; (and others) (Univ. of California, Livermore). Astrophys. J.; 164: 61-6 (15 Feb 1971).

During a controlled scan with a low-energy x-ray detector, a region of x-ray emission was located coincident with the Vela–Puppis complex of radio sources. The supernova remnant Pup A is observed as an isolated source. The Vel X region is extended, with some evidence for structure. (auth)

16682 SKY NEAR THE BRIGHTEST X-RAY SOURCE IN SCORPIUS. III. Johnson, Hugh M. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Astrophys. J.; 164: 67-76(15 Feb 1971).

New observations of H I and Hβ emission, together with existing data on H I and stellar members of the Sco–Cen association in the sky near Sco X-1, were studied with respect to the related problems of interstellar kinematics, heating, and ionization. The region is an important test case for heating and ionization by soft x rays. Radial velocities of young stars were compared with H I velocities and were found to differ in both mean and rms characteristics in the Sco–Cen association. (auth)

16683 X RAYS FROM CENTAURUS A AND THE FAR-INFRARED BACKGROUND RADIATION. Ramaty, R. (Goddard Space Flight Center, Greenbelt, Md.). Science; 171: 500-1(5 Feb 1971).

Includes reply by E. T. Byram, T. Z. Chubb, and H. Friedman.

Recently Byram et al. (1970) reported that they had detected x rays from Cen A with an observed flux in the 1- to 10-keV region of $(4.3 \pm 1.6) \times 10^{-2}$ keV cm^{-2} sec^{-1}. An inconsistency was revealed when comparing this value to infrared observations. This question is considered in some detail. A reply by Byram, Chubb, and Friedman is included. (W.D.M.)

16684 PULSAR DATA TABLES, 1 JUNE 1970. Maran, S. P.; Modali, Sarma B. (Goddard Space Flight Center, Greenbelt, Md.). Earth Extraterr. Sci.; 1: 147-50(Dec 1970).

Tables are given on positions and dispersion measures and Class I pulsation data. (W.D.M.)

16685 MEASUREMENT OF THE PULSATION RATIO OF THE CRAB NEBULA IN THE X-RAY REGION FROM 20 TO 80 keV. Deerenberg, A. J. M.; Bleeker, J. A. M. (Kamerlingh Omnes Laboratorium, Leiden). Nature (London). Phys. Sci.; 229: 113-14(25 Jan 1971).

During part of a balloon-borne search for anisotropy in the cosmic x-ray background in the energy range 20 to 80 keV conducted from Palestine, Texas on June 4, 1969, the Crab Nebula was within the field of view of the x-ray telescopes. X-ray data from this source obtained between 1611 and 1659 UT with an effective exposure of 6×10^4 cm^2 sec were used to search for the pulsar NP 0532. The outcome of the experiment was that the pulsation ratio (the ratio between the pulsed and the total x-ray flux of the Crab) could be further increased above 20 keV, evidence that favors the model proposed by Slysh (Nature (London), 224: 159-60(Oct. 11, 1969)) in which the total x-ray output of the Crab Nebula is pulsed at the source. (UK)

Solar Phenomena

Refer also to abstracts 16857, 16904, 16919, 16927, 16934, and 16952.

16686 (AD-710690) DETERMINATION OF THE MAGNETIC FIELD STRENGTH FROM DIFFERENT ABSORPTION LINES. Guseinov, M. Dzh. Translated from Izv. Krym. Astrofiz. Observ.; 39: 253-64(1969). 23p. (AFCRL-70-270; AFCRL-Trans-76). NTIS.

On the basis of spectrograms obtained with the echellette spectrograph of the tower solar telescope of the Crimean Astrophysical Observatory, the absolute values of the magnetic field strength H were determined from different absorption lines. It was found that the magnetic field strength changes from one line to another and depends both on the Rowland intensity and on the excitation potential of the lower level of the line. There is a dependence between H and mean optical depths $\bar{\tau}$ of lines. The field is very inhomogenous with depth and H increases, in the main, with the increase of $\bar{\tau}$. But in a separate case, there were both positive and negative gradients of the field into the depth of a spot. It was determined that in the period from September 2 to 5, 1961 in the spot leader of group No. 251 the magnetic field came up to the surface, and during September 5 to 7, the field expanded. (auth) (USGRDR)

16687 (AD-712020) PERIODIC FLUCTUATIONS IN FLUXES OF LOCAL RADIO-EMISSION SOURCES OF THE SUN. Gelfreikh, G. B.; Derevyanko, O. G.; Korzhavin, A. N.; Stasyuk, N. P. Translated from Soln. Dannye; 9: 88-94(1969). 14p. (AFCRL-70-0490; AFCRL-Trans-69). NTIS.

Fluctuations of solar radio emission at 4 cm were investigated, using the radio interferometer with the small base. A construction of autocorrelation functions permits the detection of fluctuations with the periods of 10 to 15 min and more, and amplitude up to 0.5 to 0.7% of the undisturbed Sun. It is shown that the periodic fluctuations of the flux are connected with separate local sources. These fluctuations are assumed to be due to proper oscillations of a coronal condensation—a condensed plasma, restricted by the magnetic field of the force lines rope in a sunspot group. (auth) (USGRDR)

16688 (AD-713112) VARIATION IN O VII X-RAY LINE EMISSION FROM THE SOLAR CORONA. Report for February–July 1970. Rugge, Hugo R.; Walker, Arthur B. C. Jr. (Aerospace Corp., El Segundo, Calif.). 15 Oct 1970. Contract F04701-70-C-0059. 23p. (TR-59(9260-02)-3; SAMSO-TR-70-358). NTIS.

The variation in intensity of the solar x-ray resonance intercombination and forbidden lines of helium-like O VII with 2800-MHz solar radio flux is presented for three solar rotations. A high correlation (r approximately equal to 0.80) exists between the intensities of all three x-ray lines and the 2800 MHz solar flux. The ratio of the forbidden to the intercombination line intensities is found to be essentially independent of long-term solar activity. This ratio is used to determine upper limits on the coronal electron density and to make inferences concerning the change in density with solar activity. (auth) (USGRDR)

16689 (AD-713229) SOLAR CHROMOSPHERE AND HIGH-ENERGY RADIATION. Report for July 1, 1969–September 30, 1970. Prince, H. D. (Michigan Univ., Ann Arbor. Dept. of Astronomy). 30 Sep 1970. Contract Nonr-1224(19). 9p. NTIS.

Work in the following areas is discussed: studies in solar spectroscopy; observations of sunspots; studies of flares and flare-rich centers of activity; and time variations in solar activity. (USGRDR)

16690 ORIGIN AND EVOLUTION OF THE SOLAR SYSTEM. II. Alfven, Hannes; Arrhenius, Gustaf (Univ. of California, San Diego, La Jolla). Astrophys. Space Sci.; 9: 3-33(Oct 1970).

The basic concepts of the accretional processes are discussed, and the inadequacy of the contractional model is pointed out. A comparison is made between the general pre-planetary state on the one hand and the present state in the asteroidal region on

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the other. A model for accretion of resonance-captured grains leading to the formation of resonance-captured planets and satellites is suggested. The relation between the accretional process and the spin of planets is analyzed. It is shown that jet streams are a necessary intermediate stage in the formation of celestial bodies. The time sequence of planet formation is analyzed, and it is shown that the newly accreted bodies have a characteristic internal heat structure; the cases of the Earth and the Moon are considered in detail. A region of high initial temperature is found at 0.4 of the present Earth radius, whereas the culminating temperature of the Moon is near its present surface. An accretional heat wave is found to proceed outwards, and may produce the observed differentiation features. (auth)

16691 EFFECT OF SELF-GRAVITATION OR FINITE ION MASS ON THE STABILITY OF ANISOTROPIC PLASMA. Kalra, G. L. (Flinders Univ., Bedford Park, Australia); Hosking, R. J.; Talwar, S. P. Astrophys. Space Sci.; 9: 34-79(Oct 1970).

The problem of stability of an unbounded anisotropic plasma characterized by different temperatures along and transverse to the magnetic field was investigated for an arbitrary direction of propagation. Chew et al (1956) equations modified to incorporate self-gravitation, finite ion Larmor radius (FLR), and Hall current were used. Uniform rotation (of an order of interest in astrophysics) was also considered. Extensive numerical treatment of the dispersion relation leads to several interesting results. Inclusion of FLR, Hall current, or both together introduces pulsational instability for propagation parallel to the magnetic field. The aperiodic growth rate of the "mirror" instability is only slightly altered due to FLR or Hall current effects. In the absence of rotation, self-gravitation, FLR, and Hall current, the growth rate decreases for the "mirror" region as the direction of propagation approaches the field direction, while the "firehose" instability persists for arbitrary propagation, even in the limiting case (the "mirror" limit) where the propagation is nearly transverse to the magnetic field. Uniform rotation altogether stabilizes the "firehose" instability for a sufficiently strong pressure (or temperature) anisotropy. Pulsational instability is introduced when both rotation and self-gravitation effects are present. Either FLR or Hall current depresses the growth rate of the "firehose" instability and introduces pulsational instability for the general case of arbitrary propagation. When FLR and Hall current effects are present simultaneously, the interaction terms due to these effects may be strongly destabilizing in nature for arbitrary propagation. (auth)

16692 EMISSION AND ABSORPTION OF CYCLOTRON RADIATION IN NONEQUILIBRIUM PLASMA. Jahn, Herbert (Heinrich-Hertz-Institut, Berlin). Astrophys. Space Sci.; 9: 153-74(Oct 1970).

From the kinetic Klimontovich theory the equation of radiative transfer for the case of homogeneous and stationary nonequilibrium plasma in a magnetic field is derived. For the sake of simplicity, only the propagation of cyclotron radiation in the direction of the magnetic field is considered. Explicit expressions for the coefficients of absorption and spontaneous emission, valid also at the cyclotron frequency, are obtained. In the final results the plasma is allowed to be weakly inhomogeneous in the z-direction. Application is made of the theory to the simple equilibrium case as a test yields the Rayleigh–Jeans formula of the blackbody radiation. (auth)

16693 SOLAR ABUNDANCE DETERMINATION. Engvold, O.; Hauge, O. (Univ. of Oslo). Nucl. Instrum. Methods; 90: 351-62(1970).

From 2nd International Conference on Beam-Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

Observational and theoretical aspects dealt with in the solar abundance determination are summarized. The solar abundances of sixty-six chemical elements are known. The abundances of some of these elements are based on one spectral line only (Ga, Ge, Sn, Er, Yb, Lu, Au, and Th), and the results may be erroneous. For six elements (B, Cs, Hg, Tl, Bi, and U) only upper limits for the abundance are given. Lines of Ho and Tb are suspected in the solar spectrum, but so far the abundances of these elements are not determined. (42 references.) (auth)

16694 PRELIMINARY INTERPRETATION OF THE IRON-SPARK LINE LIST OF FELDMAN AND COHEN. Connerade, J. P. (European Space Research Inst., Frascati, Italy). Astrophys. J.; 162: L139-43(Nov 1970).

A comparison is made between the list of iron-spark lines recently published by Feldman and Cohen and Hartree–Fock computations of wavelengths. A large number of possible identifications is suggested. (auth)

16695 BRIGHTNESS OF THE ZODIACAL LIGHT. Roosen, Robert G. (Goddard Space Flight Center, Greenbelt, Md.). Earth Extraterr. Sci.; 1: 151-4(Dec 1970).

The measurement of absolute intensities in the zodiacal light is extremely difficult. Weinberg (1969) discussed at length the differences between observers in terms of real variations in zodiacal light brightness and of differences in techniques of reduction and observation. A table is presented that contains all known photometric observations of the brightness of the zodiacal light in three perpendicular directions. (W.D.M.)

16696 IMPLICATIONS ON PARTICLE STORAGE AT THE SUN FROM OBSERVATIONS OF SOLAR-FLARE PROTON SPECTRUMS. Krimigis, S. M.; Verzariu, P. (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res.; 76: 792-807(1 Feb 1971).

Observations of the differential-energy spectrum of solar protons in the range 0.3 to 25 MeV obtained with the Injun 5 polar-orbiting satellite for the solar-particle event that began on January 24, 1969 are presented. The data show that (a) the differential energy spectrum exhibits a peak for the first few hours after the event, with the maximum intensity moving from ~1.1 MeV at ~6 hours after the flare onset to 0.54 MeV at ~12 hours after the flare, and (b) the differential intensity is a monotonically decreasing function of energy ~30 hours and ~56 hours after the flare. Spectrums observed in (a) are consistent with diffusive velocity dispersion during propagation in the interplanetary medium. The spectrums observed in (b) can be described by a power law in kinetic energy E of the form $dj/dE = KE^{-7}$. It has been suggested in the past that low-energy solar-flare particles are stored for periods of a few days in the immediate vicinity of the Sun. From spectrums in (b), upper limits to the electron (or ion) density in the (presumed) storage region in the vicinity of the Sun of 4×10^5 to 3×10^4 cm^{-3} are derived. These electron densities correspond to the solar radial distances of 3 to 6 R_s (solar radii). If adiabatic deceleration is taken into account, the densities are ~10^5 cm^{-3} corresponding to ~4 R_s. It is concluded that for the event of January 24, 1969, storage of low-energy protons did not take place in the immediate (3 to 6 R_s) vicinity of the Sun. The implications of the results are discussed in the context of current models of low-energy solar-particle propagation. (auth)

16697 RECURRENT SOLAR COSMIC-RAY EVENTS AND SOLAR M REGIONS. McDonald, F. B.; Desai, U. D. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 76: 808-27(1 Feb 1971).

During the latter stages of cycle 19, a characteristic series of M-region magnetic storms were observed from 1962–1964. Energetic particle events were associated with many of these storms. The relation between the corotating particle stream and magnetic disturbances is examined. These particle increases appear to be similar to those that sometimes appear on the next solar rotation after a large flare-associated particle event. Both sets of data strongly suggest that the volume above some active centers is magnetically closed. This provides the trapping region with particles preferentially escaping from the base of the preceding portion of the bipolar region. Many of the statistical studies of M regions, which established that there is a geomagnetic minimum some 3 days after the central-meridian passage of an active center, support this view. A simple model for these particle events is proposed. (auth)

16698 ENERGY TRANSFER AT COLLIDING STREAMS IN THE SOLAR WIND. Burlaga, L. F. (Goddard Space Flight Center, Greenbelt, Md.); Ogilvie, K. W.; Fairfield, D. H.; Montgomery, M. D.; Bame, S. J. Astrophys. J.; 164: 137-49(15 Feb 1971).

Explorer 34 and Vela 4B measurements of the relevant proton, α-particle, electron, and magnetic-field parameters for three events were used to investigate processes occurring when a fast stream of solar plasma overtakes a slower one. The protons are heated by an amount such that the maximum thermal speed approximately equals the relative speed of the two streams. The thermal anisotropy of the protons does not increase, an observation which indicates either that the heating is not due to hydromagnetic-wave damping alone or that both MHD heating and an isotropization mechanism are operative. The α particles are heated in proportion to the protons, but the electron temperature does not measurably increase. The intensity of the magnetic field reaches a maximum after the density, and the field fluctuations with frequencies of $(1.5 \text{ to } 6) \times 10^{-3}$ Hz are unusually high in the hot spots but not adjacent to them. The hypothesis that such fluctuations are propagating from colliding streams is not supported. The proton density and temperature profiles are consistent with the results of a nonsteady, nonlinear adiabatic fluid model. A hydromagnetic three-fluid model with heat conduction is needed to explain the other observations. (auth)

16699 IMPULSIVE HARD X-RAY AND ULTRAVIOLET EMISSION DURING SOLAR FLARES. Kane, S. R. (Univ. of California, Berkeley); Donnelly, R. F. Astrophys. J.; 164: 151-63(15 Feb 1971).

Impulsive solar bursts of hard x rays observed by the satel-

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lites OGO-1, 3, and 5 were studied in comparison with the concurrent enhancement of 10 to 1030 Å radiation observed by means of sudden frequency deviations (SFD). The average ratio of the maximum enhancement of the impulsive flux at 10 to 1030 Å to the maximum energy flux of x rays at photon energies ≳10 keV is found to be ~10^5. The ratio decreases with increasing central meridian distance (CMD) of the Hα flare. This effect is believed to be due to the increase in extreme-ultraviolet absorption by the solar atmosphere with the increase in CMD of the flare. The spectrum of the energetic electrons in the x-ray source region deduced from the observed x-ray spectrum indicates that the total kinetic energy in these electrons is comparable to that required to explain the enhancement of the 10 to 1030 Å flux. Interpretation of the observations indicates that the principal mechanism for the impulsive emission of 10 to 1030 Å radiation during some hard x-ray events is the free–bound, bound–bound, and bremsstrahlung emission from the quasi-thermal plasma produced by the collision loss of energetic (≳10 keV) electrons in the partially ionized solar plasma of density ≳10^{12} cm^{-3}. These energetic electrons are the common link between the impulsive hard x-ray, extreme-ultraviolet, and microwave emission during solar flares. (auth)

16700 HELIUM-LIKE CALCIUM EMISSION OBSERVED DURING A SOLAR FLARE. Doschek, G. A.; Meekins, J. F.; Kreplin, R. W.; Chubb, T. A.; Friedman, H. (Naval Research Lab., Washington, D. C.). Astrophys. J.; 164: 165-80(15 Feb 1971).

An analysis is presented of x-ray line emission from helium-like calcium and related satellite lines produced by the large flare of November 2, 1969. The data were obtained from an NRL Bragg crystal spectrometer aboard OSO-6. The inner-shell transition of Ca^{+17}, $1s^2 2s\ ^2S - 1s2s2p\ ^2P$, and the forbidden of Ca^{+18}, $1s^2\ ^1S - 1s2s\ ^3S$, are clearly resolved. The intercombination line of Ca^{+18} is numerically separated into contributions from the $2\ ^3P_1$ and $2\ ^3P_2$ levels. Time histories of the flux of the resonance ($1s^2\ ^1S - 1s2p\ ^1P$), intercombination ($1s^2\ ^1S - 1s2p\ ^3P$), and forbidden ($1s^2\ ^1S - 1s2s\ ^3S$) lines of Ca^{+18}, and the inner-shell K-line of Ca^{+17} ($1s^2 2s\ ^2S - 1s2s2p\ ^2P$), indicate that recombination is an important process for line formation under flare conditions. For the November 2 event, no statistically significant changes in the ratio of the forbidden to intercombination lines occurred during the time interval of observation. (auth)

16701 OBSERVATION OF AUTOIONIZING STATES IN THE SOLAR CORONA. Walker, A. B. C. Jr.; Rugge, H. R. (Aerospace Corp., El Segundo, Calif.). Astrophys. J.; 164: 181-90 (15 Feb 1971).

Weak satellites to the lines of the principal series of the helium-like and hydrogen-like ions of magnesium, aluminum, silicon, and sulfur were observed in the solar spectrum. These lines coincide in wavelength with the extrapolated positions of transitions from the $2s2p\ ^3P$ and $2p^2\ ^1D$ auto-ionizing levels in helium-like ions, and the $1s2s2p\ ^2P$, $1s2s3p\ ^2P$, and $1s2p3p\ ^2S$ or ^2D autoionizing levels in lithium-like ions. The observed ratio of the intensity of the $1s2p\ ^1P - 2p^2\ ^1D$ line in Mg XI relative to the intensity of the Mg XII Lα line was found to be 5×10^{-3}, compared with a predicted ratio which varied from 16×10^{-3} at 6×10^6 °K to 7.5×10^{-3} at 10^7 °K. The observations provide direct evidence of dielectronic recombination in the corona. (auth)

16702 ANGULAR DIMENSIONS OF SOLAR CORPUSCULAR STREAMS. Danilov, A. A.; Plotnikov, I. Ya. (Inst. of Cosmophysical Investigations and Aeronomy, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 104-6(1970).

Translated from Geomagn. Aeron.; 10: 134-5(1970).

Geomagnetic activity experiences semiannual variations with maxima around the equinoxes and minima around the solstices. This phenomenon is attributed to the fact that the intensity of solar corpuscular emission is less in the equatorial plane than over the latitudes of sunspot formation zones. The semiannual magnetic-activity wave appears as a result of the annual variation of the quantity $\Delta\varphi = \varphi_a - \varphi_E$, where φ_a is the heliolatitude of the sunspot formation zone and φ_E is the heliolatitude of the Earth. The φ_a varies within ±(8 to 35°) in the 11-year cycle and the semiannual magnetic-activity wave must vary with the same period. The geometric dimensions of the solar corpuscular streams may be investigated. A method is given for determining the angular dimension of a corpuscular stream in the meridional plane of the Sun. The 3-hour K indexes of Yakutsk Observatory from 1938 to 1965 for nearly 3 solar cycles were used as initial data. The analyses of the data are given and the average angular dimension of the streams in the meridional plane of the Sun is ~30°. (J.C.W.)

16703 MINIMUM TEMPERATURE AND POWER EFFECT OF COSMICAL PLASMAS INTERACTING WITH NEUTRAL GAS. Lehnert, B. (Royal Inst. of Tech., Stockholm). Cosmic Electrodyn.; 1: 397-410(Dec 1970).

There exist regions in the cosmos, such as the surface layers of stars and cool interstellar clouds, that are slightly ionized in an undisturbed state. Fully ionized plasmas produced within limited volumes of these regions will interact with the surrounding neutral gas through partially ionized boundary regions in a way depending on an immersed magnetic field. In systems of this type the power balance is associated with sharp transitions of the plasma state, effects of element and isotope separation become operative, and rotating plasma states are likely to be established. On account of the neutral-gas interaction, a minimum power input and temperature exist below which the fully ionized plasma cannot be sustained in a quasi-stationary state. This limit is sharply defined and should, under certain conditions, produce abrupt disappearances or appearances of cosmical phenomena both in time and space, even when the parameters involved are being changed gradually and slowly. Possible applications of this effect are related to solar prominences and their sudden disappearance and to rotating plasmas created by electrical discharges in the solar atmosphere. The mechanisms that produce the minimum power effect are based on an overall plasma balance and differ from the local radiation and recombination balance earlier considered by Strömgren in connection with interstellar clouds. An experimental demonstration of the present effect is given under laboratory conditions and its scaling to cosmical conditions is discussed. Under certain conditions there should also exist a sharply defined transition when a fully ionized magnetized plasma is created from a cloud of neutral gas. (auth)

16704 SOME RESULTS IN THE COMPARISON OF CORONAL DATA. Obashev, S. O. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 15: 6-9(1969). (In Russian).

On the ground of comparisons of the data of different coronal, stations, using the same type of instruments and the unified methods for observations and treatments of the data received, the author comes to the conclusion that it is impossible to expect the total identity of the obtained data. The difference, on the one hand, is due to the nature of the corona itself, and on the other hand, to arbitrary observation and treatment errors. (auth)

16705 INFLUENCE OF ELECTRIC FIELDS ON THE PROFILES OF CORONAL LINES. Obashev, S. O.; Vil'koviskii, E. Ya.; Zubtsov, A. S. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 15: 10-15(1969). (In Russian).

The influence of weak electric fields on the profiles of the coronal lines is considered. The kinetic temperature appears to be less than the one obtained from the observed half-width. (auth)

16706 MAIN ERUPTIVE PHASE OF SOLAR FLARES. Obashev, S. O. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 15: 16-21(1969). (In Russian).

The theory of the point flare in the heterogeneous atmosphere is used for solar flares. The energy of the solar flares in the main eruptive phase is estimated to be about 3×10^{25} erg, and it is obtained in the form of a shock-wave front for different time moments. The curve of area development of solar flares shows the same run as the shock-wave front and changes according to the law: $S = S_0 t^{1/2}$. The observed points are systematically higher than the theoretical ones. It can be concluded that the solar flares are generated in low chromosphere layers. (auth)

16707 ERUPTIONS IN THE SOLAR ATMOSPHERE AND STRUCTURE OF THE CHROMOSPHERE. Obashev, S. O. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 15: 22-6(1969). (In Russian).

Some physical parameters of solar eruptions, observed on Oct. 23, 1957 and Apr. 2, 1960 with the photosphere–chromosphere telescope AFR-2, using the IPF are considered. The total number of hydrogen atoms, enclosed in the eruption of Oct. 23, 1957 equals 10^{41}. Comparing the gas mass contained in the eruption with the mean chromosphere mass, the author concludes that eruptions are deep-layer formations taking place in the photosphere or low chromosphere. The kinetic energy of the eruption is about 10^{31} erg. This is approximately equal to a flare energy. It is possible that flares and eruptions are the same phenomenon but have different appearances, in dependence on the magnetic field configuration in active regions. The latter reveals a dark halo in the line wings of Hα, and the size of this halo is ten times larger than the one of the structural elements of the chromosphere. (auth)

16708 POSSIBLE RELATION BETWEEN DIFFERENT PARAMETERS OF SOLAR FLARES. Obashev, S. O. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 15: 27-37(1969). (In Russian).

Some relations and quantitative estimates of the parameters of

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solar flares are obtained on the basis of the simple physical assumption that in solar flares some part of energy is transformed into radiation. In particular, the formula for changing of a flare area is deduced, and the relation between the values S_m and T is found. The total energy of a flare is estimated, and an energy classification is proposed. (auth)

16709 LONGITUDINAL DISTRIBUTION OF SUNSPOT GROUPS IN THE LAST 11 YEARS OF SOLAR ACTIVITY. Morozov, N. N.; Obashev, S. O. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 15: 38-45(1969). (In Russian).

Using correlation functions the existence of a period in the longitudinal distribution of sunspot groups is established, which does not remain constant during the cycle and is not always similar in different hemispheres of the Sun. The value of the period is, evidently, correlated with the mean characteristic line size of active regions, which undergoes essential variations during the cycle phase. Active regions in different hemispheres are as if moved with respect to one another. (auth)

16710 CATALOG OF SOLAR FLARES. Zubtsov, A. S.; Obashev, S. O. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 15: 46-60(1969). (In Russian).

A catalog of solar flares, observed at the high-altitude station Kazakh SSR during the IGY–IQSY is given. This catalog contains the main flare characteristics: the times of beginning and the end of the appearance of the flare, the flare importance, and the coordinates of the flare. On the graphs, the patrol time of the solar flares is dotted. (auth)

16711 SUNSPOTS IN THE YEAR 1969. Mergentaler, Jan (Astronomical Observatory, Wroclaw). Acta Geophys. Pol.; 18: 395-7(1970).

Sunspot observations for 1969 are discussed. The fourteen observations tabulated include a coefficient reducing the observations to a homogeneous scale and the number of days observations were made. Wolf or sunspot numbers are listed. The year mean-relative number for 1969 is 98.4, is lower than 1968, and does not coincide with predictions. The mean Wolf numbers are tabulated for synodic rotations numbered according to Carrington's system. (J.C.W.)

16712 VARIABLE ELECTRICAL CONDUCTIVITY IN SUNSPOT STRUCTURE. Chen, Yud-ren. Rochester, N. Y.; Univ. of Rochester (1970). 146p. University Microfilms Order No. 70-17,866.

Thesis.

Recent works by Schröter (1964), Oster (1968), and Kopecký and Kuklin (1969) have shown that the umbral electric conductivity is much lower than the normal photospheric conductivity. In the present work, some of the effects of the variation in conductivity are analyzed. (TSS) (Diss. Abstr. Int., B)

16713 RELATIVE OSCILLATOR STRENGTHS FOR Fe I TO Ni I LINES AND THE SOLAR ABUNDANCE RATIO Fe/Ni. Garz, T. (Univ., Kiel). Astron. Astrophys.; 10: 175-81(Jan 1971). (In German).

Recently the iron abundance for the solar photosphere was determined with new Fe I oscillator strengths (Garz et al., 1969) and is now in agreement with the iron abundance in the corona. Using new oscillator strengths of Ni I measured by Garz, Heise, and Richter (1970) and the solar model of Holweger (1967) a photospherical abundance of nickel $\log \epsilon(\mathrm{Ni}) = 6.25 \pm 0.15$ — ($\log \epsilon(\mathrm{H}) = 12$) — was derived. This value is about a factor 2 greater than determinations by others (i.e. Goldberg et al., 1960) but agrees with the coronal abundance determinations. To verify these results, two independent measurements of relative oscillator strengths for the ratio of Fe I to Ni I were carried out. First, a wall-stabilized arc burning in argon served as a light source. An aerosol of iron nitrate and nickel nitrate in known composition was brought into the plasma. Secondly, the spectra of a spark between electrodes of a known iron-to-nickel ratio were analyzed. The relative log(gf) values of both experiments in connection with the solar log(gfε) values calculated by Holweger led to the relative abundance for the solar photosphere,

$$\log \frac{\epsilon(\mathrm{Fe})}{\epsilon(\mathrm{Ni})} = 1.25 \pm 0.15,$$

in agreement with the above absolute determinations. Furthermore, the carbonaceous chondrites, according to published data, yield a relative abundance

$$\log \frac{\epsilon(\mathrm{Fe})}{\epsilon(\mathrm{Ni})} = 1.29 \pm 0.05.$$

Thus there is no difference in the relative abundance of the iron-to-nickel ratio in the solar photosphere, the corona, and the carbonaceous chondrites. (auth)

16714 HEAT CONDUCTION IN THE SOLAR TRANSITION LAYER AND THE RELATION BETWEEN TEMPERATURE AND DENSITY OF CORONAL ACTIVE REGIONS. Reimers, D. (Univ., Kiel). Astron. Astrophys.; 10: 182-6(Jan 1971).

It is shown that a rather wide class of heat source distributions in the solar transition layer leads to the same temperature model. Thus, it appears impossible to draw any quantitative conclusions about dissipation of shock waves from an empirical model of the solar transition layer. Using the theories of heat conduction and hydrostatic equilibrium and a rough estimate for the balance between the dissipation of mechanical energy and radiation at the base of the solar transition layer, a quantitative relation between electron density and temperature enhancement for coronal active regions (condensations or rays) is derived as

$$\Delta \log N = \frac{5}{2} \Delta \log T.$$

This relation is shown to be in good agreement with observations. Implications and possible future applications are discussed. (auth)

16715 ABSOLUTE MEASUREMENTS OF SOLAR FLUX AT 16 AND 30 GHz. Wrixon, G. T.; Hogg, D. C. (Bell Telephone Labs., Inc., Holmdel, N. J.). Astron. Astrophys.; 10: 193-7 (Jan 1971).

Using an absorbing disc for antenna calibration, absolute flux measurements of the Sun were obtained at 16 and 30 GHz. Measured values of the solar disc temperature were 12,500°K at 16 GHz and 10,480°K at 30 GHz. The absolute errors associated with these values were +1.8%, −2.5% at 16 GHz and +2.4%, −3.0% at 30 GHz. Within experimental error no variation of flux was observed during the measurements, which took place on five days in the period September 1969 through March 1970. (auth)

16716 SMALL-SCALE PLASMA IRREGULARITIES IN THE INTERPLANETARY MEDIUM. Little, L. T. (Univ. of Kent, Canterbury, Eng.). Astron. Astrophys.; 10: 301-5(Jan 1971).

Arguments are presented to show that the small scale (~100 km) plasma irregularities in the interplanetary medium, studied by interplanetary scintillation techniques, form a distribution distinct from the larger-scale ($\sim 10^6$ km) inhomogeneities detected by space probes. Measurements of the small-scale irregularities close to the Sun, made using spaced antennas at the Goldstone Deep Space Tracking Station, are combined with others made previously at greater distances to derive the variation of scale with solar elongation for distances greater than 6 $R_\odot$. The deviation of electron density for these irregularities is considered and shown to follow a law $\Delta n \propto r^{-2.6 \pm 0.2}$ over the range $0.05 < r < 0.8$ au. (auth)

16717 MOTION OF THE SOLAR WIND CLOSE TO THE SUN. Ekers, R. D.; Little, L. T. (California Inst. of Tech., Pasadena). Astron. Astrophys.; 10: 310-16(Jan 1971).

The motion of interplanetary irregularities was derived in the range of solar elongation 6 to 40 $R_\odot$ from observations of interplanetary scintillation using spaced receivers at the Goldstone Deep Space Tracking Station, California. The acceleration of the irregularities was found to be consistent with that predicted for a Parker solar wind model having a coronal temperature $\sim 1 \times 10^{6}$°K. There is evidence for high turbulent velocities of the irregularities that persist out to about 30 $R_\odot$ and account for the "high-frequency tails" in the scintillation spectra observed by other workers. (auth)

16718 INHOMOGENEOUS CONVECTION AND THE EQUATORIAL ACCELERATION OF THE SUN. Durney, B. R. (High Altitude Observatory, Boulder, Colo.); Roxburgh, I. W. Solar Phys.; 16: 3-20(Jan 1971).

The interaction of rotation and turbulent convection is assumed to give rise to an inhomogeneous, but isotropic, latitude-dependent turbulent energy transport, which is described by a "convective conduction coefficient κ_c" that varies with latitude. Energy balance in the convective zone is then possible only with a slow meridian circulation in the outer convective zone of the Sun. The angular momentum transported by this circulation is balanced in a steady state by turbulent viscous transport down an angular velocity gradient. A detailed model is constructed allowing for the transition from convective transport to radiative transport at the boundaries of the convective zone, by using a perturbation analysis in which the latitude variation of κ_c is small. The solution for a thin compressible shell gives equatorial acceleration and a hotter equator than pole, assuming that the convection is preferentially stabilized at the equator. For agreement with the Sun's equatorial acceleration the model predicts an equatorial temperature excess of 70°K and a surface meridional velocity of 350 cm/sec from pole to equator. (auth)

16719 LARGE-SCALE VELOCITY FIELDS OF THE SOLAR ATMOSPHERE. Howard, Robert (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys.; 16: 21-36(Jan 1971).

Magnetograph velocity data are studied for evidence of large-scale velocity fields. It is established that there exist on the surface of the Sun regions of more or less coherent downward motion with dimensions of the order of a solar radius. Velocity amplitudes in these regions are in the range 50 to 75 m/sec. Downward-moving large-scale features are observed to live for at least several days in general and to rotate at least approximately with the solar rotation rate. Horizontal east–west motions appear to have lifetimes of at least many months. The extent in longitude of these horizontal features is about 25°. There is no evidence for meridional motions from these data, with an upper limit to the line-of-sight velocity of about 30 m/sec. Active regions, as reported previously, are areas of generally downward motion. Some features in the autocorrelation of the rotational velocity of the Sun remain unexplained. (auth)

Galaxies

16720 (AD–712807) RICH CLUSTERS OF GALAXIES. Final Technical Report. Abell, George O. (California Univ., Los Angeles). 30 Sep 1970. Contract N00014-67-C-0197. 6p. (TR–10). NTIS.

Rich clusters of galaxies are reviewed. Progress was made in the study of distributions of clusters in groups of various richness. Photometry studies were completed on the elliptical galaxies in the Virgo Cluster. (auth) (USGRDR)

16721 WEAKNESS OF DIFFUSE GALACTIC LIGHT OFF THE MILKY WAY. Dumont, R. (Observatoire, Bordeaux); Soulie, G.; Rapaport, M.; Sanchez-Martinez, F. Astrophys. Space Sci.; 9: 175-80(Oct 1970).

Observations were selected in Tenerife Zodiacal Light Data, which made it possible to separate the diffuse galactic light from other components. Far from the Milky Way ($30° \leq |b| \leq 60°$) the diffuse galactic light shows a decreasing slope which cannot exceed -0.3 S_{10} vis. per degree of galactic latitude, and is probably a very weak component of the total extraterrestrial light. (auth)

16722 MODELS FOR THE STABILIZATION OF CLUSTERS OF GALAXIES BY HOT GAS CONSISTENT WITH OBSERVATIONS OF PKS 1116 +12. Noerdlinger, Peter D. (New Mexico Inst. of Mining and Tech., Socorro. Ames Research Center, Moffett Field, Calif.). Astrophys. J.; 164: 217-21(15 Feb 1971).

Models are constructed for producing the absorption spectrum of the QSS PKS 1116 + 12 based on gas distributed in a cluster of galaxies. High-temperature ($\sim 10^6$ °K) models with collisional ionization and low-temperature ($\sim 10^4$ °k) models with ionization by diffuse cosmic photons can both be constructed with enough gas to stabilize the cluster. The high-temperature models are short-lived unless the galaxies provide considerable ($\lesssim 10^{45}$ ergs sec^{-1}) heating. (auth)

16723 PHOTOELECTRIC SPECTROPHOTOMETRY OF SEYFERT GALAXIES. Wampler, Joseph E. (Univ. of California, Santa Cruz). Astrophys. J.; 164: 1-9(15 Feb 1971).

Observational evidence is given for the existence of substantial amounts of reddening in the nuclei of NGC 1068 and NGC 1275. The reddening agent appears to be closely confined to the semi-stellar nuclei of the galaxies since photometry immediately outside the nuclear region produces energy distributions similar to the presumably unreddened nuclear region of M51. The slope of the energy distribution of the "nonthermal" nucleus is substantially reduced by the reddening corrections and corrections for the stellar background. (auth)

16724 COLOR CHANGES AND ABSORPTION-LINE VARIATIONS OVER THE INNER DISK OF M31 AND THE CENTRAL REGIONS OF M32 AND NGC 4472. Spinrad, Hyron (Univ. of California, Berkeley. Jet Propulsion Lab., Pasadena, Calif.); Gunn, James E.; Taylor, Benjamin J.; McClure, Robert D.; Young, James W. Astrophys. J.; 164: 11-22(15 Feb 1971).

Photoelectric-scanner and interference-filter measures were obtained of the CN band at λ4200, the Mg b-lines, and the Na D-lines over the inner disk of M31, from the nucleus to about 1 kpc in projected distance. A few similar, but somewhat less precise, measures were obtained near the center of M32, and to a radial distance of some 1.8 kpc from the nucleus of the giant E galaxy NGC 4472. More extensive scanner observations of a point 1′ south of the M31 nucleus were also obtained. The CN absorption drops sharply with radial distance in all three galaxies, as found earlier by McClure. In M31, the strengths of the Na D-lines drop off slowly with radial distance from the nucleus. The Mg triplet shows essentially no change in strength in M31 and decreases somewhat at 1.8 kpc from the NGC 4472 nucleus. The U–B indices of all three galaxies also become noticeably smaller outward from their nuclei, while available red and infrared photometry shows the galaxy colors at $\lambda \geq 6000$ Å to be constant (Sandage, Becklin, and Neugebauer). A preliminary synthesis of the disk population of M31 was attempted. Its mass-to-light ratio is probably equal to or slightly greater than the nuclear value of 45 suggested by Spinrad and Taylor. On the other hand, the metal abundance at 200 to 500 pc from the center of M31 and at perhaps 1 kpc from the nucleus of NGC 4472 appears to be close to the solar level, in contrast to high abundances found at their nuclei. Farther from the nucleus, a weak line population may make a significant contribution to the integrated spectrum, but there is still no evidence for a dominant globular-cluster population in the halo as envisioned by Baade. (auth)

16725 COMPARISON OF 21-cm RADIAL VELOCITIES AND OPTICAL RADIAL VELOCITIES OF GALAXIES. Ford, W. Kent Jr. (Carnegie Institution of Washington, D. C.); Rubin, Vera C.; Roberts, Morton S. Astron. J.; 76: 22-4(Feb 1971).

New optical determinations of the systemic radial velocities of 27 galaxies are given. These redshifts, together with older values from the literature, are compared to redshifts derived from 21-cm measurements. The older optical data show a significantly larger mean difference from the 21-cm values, than do the new determinations. In addition, the optically derived rotation curve for NGC 5033 is presented. (auth)

16726 FLUX DENSITIES OF RADIO GALAXIES AT 8000 MHz. Stull, M. A. (Univ. of Michigan, Ann Arbor). Astron. J.; 76: 1-4(Feb 1971).

The flux densities at 8000 MHz of 60 Parkes Catalogue radio galaxies were measured with the University of Michigan 85-ft radio telescope. Beam broadening was also measured for some of the stronger sources. PK 0048–09, a blue galaxy of undetermined type, has previously been reported to vary in flux; new data indicate that these variations are unusually rapid. (auth)

16727 MULTIDIMENSIONAL CLASSIFICATION OF GLOBULAR CLUSTERS. Castellani, V. (Univ., Rome); Giannone, P.; Renzini, A. Astrophys. Space Sci.; 9: 418-39(Dec 1970).

Forty-two galactic globular clusters are classified according to the five observational parameters: S and $(B-V)_{o,g}$, used by Hartwick, $\bar{P}_{ab}$, the mean period of the ab-type RR Lyrae variables, n_c/n_{ab}, the relative number of the c-type to the ab-type RR Lyrae variables and the reddening-free parameter $Q = (U-B) - 0.72(B-V)$. Seven groups are isolated; a consistency between the Hartwick classification and a subdivision based on the RR Lyrae properties is shown. Globular clusters are confirmed to form a two-parameter family of objects, which means that probably only another parameter in addition to the metal abundance must vary from a cluster to another. Evolutionary considerations in relation to the HB characteristics are given in detail. Implications concerning the initial galactic structure and the helium problem are briefly discussed. (auth)

16728 RADIO OBSERVATIONS OF NEUTRAL HYDROGEN IN FOUR SEYFERT GALAXIES. Allen, R. J. (Kapteyn Astronomical Lab., Groningen, Netherlands); Darchy, Bernard F.; Lauque, R. Astron. Astrophys.; 10: 198-204(Jan 1971).

The 21-cm-wavelength radiation from neutral hydrogen in NGC 1068, NGC 3227, NGC 4051, and NGC 4151 was observed with the large radio telescope at Nançay, France. Since the angular sizes of these galaxies are of the same order as the telescope right ascension beamwidth, no information on the angular distribution of the neutral hydrogen was obtained. However, the radial velocity distribution of the total hydrogen (the "integrated profile") of the whole galaxy was measured for each of the four galaxies. The hydrogen masses and total masses can be calculated from these profiles using simple models of galaxy shapes and rotation curves. Optical spectra sometimes show evidence for explosive phenomena and radial outflow of gas in the central regions of Seyfert galaxies. The integrated radio profiles were examined for indications of large-scale radial motions of neutral hydrogen in two ways. First, for all four galaxies observed, the ratios of hydrogen mass to total mass were compared with the values obtained from other galaxies (not Seyfert) of the same morphological type. Second, for these galaxies where the optical data are available, the estimate of total mass obtained from the optical spectra was compared with the estimates based on the width of the radio profile. It was concluded from these comparisons that the integrated profile of NGC 1068 is unusually broad. One possible interpretation, which is qualitatively consistent with the optical data, is that an appreciable fraction (about ⅓) of the neutral hydrogen content of NGC 1068 is

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moving radially outward with velocities of about 150 km s^{-1}. An indication of similar phenomena (although less extreme) is obtained for NGC 4051. The widths of the integrated profiles of NGC 3227 and NGC 4151 do not seem unusual. (auth)

Cosmology

16729 LINEARIZED GRAVITATION THEORY AND THE GRAVITON MASS. Zakharov, V. I. JETP Lett. (USSR) (Engl. Transl.); 12: 312-14(5 Nov 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red., 12: 447-9(5 Nov 1970).

It is shown that in the linearized gravitation theory there is no continuous transition to the limit with respect to the graviton mass. The solutions of the equations of the linearized gravitation theory, obtained for the case of a finite graviton mass as the mass approaches zero, do not go over into the solution of the linearized equations of general relativity theory. (W.D.M.)

16730 PARTICLE PRODUCTION IN COSMOLOGY. Zel'dovich, Ya. B. (Inst. of Applied Mathematics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 12: 307-11(5 Nov 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 443-7 (5 Nov 1970).

The question of particle production is considered in the cosmological problem as applied to an isotropic (Friedmann) solution in a paper by Parker (1969). A singularity of the Kasner type is considered here. (W.D.M.)

16731 SMALL SCALE ENTROPY AND ADIABATIC DENSITY PERTURBATIONS: ANTIMATTER IN THE UNIVERSE. Sunyaev, R. A.; Zeldovich, Ya. B. (Inst. of Applied Mathematics, Moscow). Astrophys. Space Sci.; 9: 368-82(Dec 1970).

Fluctuations of all scales are equally interesting from the point of view of the characteristics of the singular state and not only those that led to the formation of astronomical objects such as clusters of galaxies, separate galaxies, globular clusters, and quasars. Estimates are given of the homogeneity of the overall density of hot plasma and the relation between the quantity of baryons and antibaryons at early stages of evolution of the Universe. These estimates are made for small scales, considerably smaller than the scale of the astronomical objects enumerated above. Considerations about the energy balance of hot plasma and distortions of the spectrum of relict radiation due to dissipation of density fluctuations of matter are used for these estimates. The corrected upper limit to early energy injection is given. In a preceding paper (Sunyaev and Zeldovich, 1970) this upper limit was underestimated. Difficulties with a model of the Universe which is symmetric in baryon charge are noted. (auth)

16732 PLASMON NEUTRINOS EMISSION IN A STRONG MAGNETIC FIELD. II. LONGITUDINAL PLASMONS. Canuto, V.; Chiuderi, C.; Chou, C. K. (Goddard Space Flight Center, New York). Astrophys. Space Sci.; 9: 453-60(Dec 1970).

The decay of a longitudinal plasmon into two neutrinos is studied in the presence of a strong magnetic field. Contrary to the transverse case, for longitudinal plasmons the existence of a new mode, entirely dependent on the magnetic field, greatly enhances the energy loss at high densities. Denoting by Q_H and Q_O the neutrino energy losses with and without magnetic field, respectively, the situation is as follows: at $H \simeq 10^{11}$ G and $T \geq 10^9$ K $Q_O \gg 10^5 Q_H$ for $\rho < 10^{11}$ g cm^{-3}, while $Q_H \gg 10^{10} Q_O$ for $\rho > 10^{11}$ g cm^{-3}. A second physically interesting feature is the anisotropic character of the energy loss, which is highly peaked along the field lines, giving rise to a shorter cooling time in that direction than in any other. (auth)

16733 THEORY OF EVOLUTION OF HOMOGENEOUS COSMOLOGICAL MODELS. Khalatnikov, I. M.; Pokrovskii, V. L. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 59: 1812-18(Nov 1970). (In Russian).

Evolution of homogeneous type-VIII and -IX metrics is investigated. An analytical solution of the Einstein equations valid for arbitrary oscillation amplitudes is found for a long era when two of the metric coefficients oscillate and another decreases in time. (auth)

16734 METHODS OF PLASMA THEORY AND THE PROBLEM OF GRAVITATIONAL STABILITY. Mikhailovskii, A. B.; Fridman, A. M.; Epel'baum, Ya. G. (Novosibirsk State Univ., USSR). Zh. Eksp. Teor. Fiz.; 59: 1608-17(Nov 1970). (In Russian).

Stability of a spherically symmetric system of masses rotating along a circular trajectory is investigated. Analysis of stability is carried out by applying the collisionless Boltzmann–Vlasov kinetic equation. A method for solving the equation is presented that is similar to the well-known method of integration over trajectories in plasma physics. Stability of the system with respect to arbitrary perturbations may explain the experimental fact that the age of spherical stellar clusters is great compared to the age of spiral galaxies. (auth)

16735 ORIGIN OF MATTER AND GALAXIES. Omnes, R. (Laboratories de Physique et Hautes Energies, Orsay, France). Astron. Astrophys.; 10: 228-45(Jan 1971).

In previous publications, a mechanism was proposed for the separation of nucleons and antinucleons in the thermal radiation at very high temperatures (kT > 350 MeV). The consequences of this effect in a homogeneous and isotropic model Universe containing initially only thermal radiation was studied in detail. The salient points are: (a) a study of the growth of the initial condensations, (b) a discussion of the rate of annihilation, (c) the study of a mechanism, induced by annihilation pressure for the growth of condensations below kT = 25 keV. The main results are a calculation of matter density, and of the size and mass of condensations at the end of the radiative era. They agree well with the observed density of matter and the size and mass of galaxies. Further consequences relating to quasi-stellar objects, galactic nuclei, intergalactic matter, and γ-ray astronomy are briefly discussed. (auth)

16736 BASIC INTERRELATIONSHIPS BETWEEN THERMODYNAMICS, RELATIVITY, AND COSMOLOGY. Gal-Or, B. (Technion-Israel Inst. of Tech., Haifa). Scienta (Milan); 105: 361-9(Jul-Aug 1970).

Is the origin of irreversibility in nature local or cosmological? Is it in the laws or in the boundary conditions? What might be the interrelationships between the expansion of the Universe, information, and the arrow of time? Such questions and related topics are discussed, showing that the search for a new entropy-free thermodynamics linked with cosmology and general relativity is not merely an academic, aesthetic, and logical necessity, but it may as well be a result of the failure of present-day thermodynamics to solve existing contradictions and paradoxes. A review of various and sometimes conflicting opinions expressed by eminent scientists in regard to the role the second law of thermodynamics plays in nature is included. Also included is a short discussion on time asymmetries and the origin of life. (auth)

Planetary Phenomena

Refer also to abstracts 17033 and 17549.

16737 (UCB-34-P-32-0-3) SOME SPECIFIC RARE GAS STUDIES IN APOLLO SAMPLES. Alexander, E. C. Jr.; Davis, P. K.; Kaiser, W. A.; Lewis, R. S.; Reynolds, J. H. (California Univ., Berkeley. Dept. of Physics). [1970]. Contract AT(04-3)-34. 10p. (CONF-710102-1). Dep. NTIS.

From 2nd Annual Lunar Science Conference, Houston, Tex.

Stepwise heating analyses of rare gases from pile-irradiated rocks 10044 and 10057, further rare-gas studies in rock 12013, and depth studies of rare gases in rock 12002 are reported. (W.D.M.)

16738 COSMIC-RAY IONIZATION IN ATMOSPHERES OF PLANETS. Velinov, P. (Geophysical Inst., Sofia). Compt. Rend. Acad. Bulg. Sci.; 23: 1195-8(1970).

Ionization by cosmic rays in planetary atmospheres is examined theoretically. Data on cosmic-ray ionization of the Earth's atmosphere are presented. The ionizing capability of cosmic rays at different heights is almost constant above the maximum of the ionic region and an expression is given. A comparison between the ionization of cosmic rays and solar radiation shows the solar radiation to be dominant on Earth. Solar radiation dominates on Mercury, Venus, Earth, and Mars, while cosmic radiation dominates on Jupiter, Saturn, Uranus, Neptune, and Pluto. The ionization losses of particles are described by means of the Bethe–Bloch formula. The theoretical presentation may be applied to all the atmospheres and depends little on the gas composition of the planet. (J.C.W.)

16739 DENSITY DISTRIBUTION IN JUPITER'S MAGNETOSPHERE. Parthasarathy, R.; Whitten, R. C.; Sims, J. S. (Ames Research Center, Moffett Field, Calif.). Cosmic Electrodyn.; 1: 311-15(Dec 1970).

Plasma density distribution in Jupiter's rotating, inner magnetosphere is investigated, with a Lorentz force term in the force balance equation. The term enables derivation of outwardly decreasing density, despite strong centrifugal forces beyond a few planetary radii. (auth)

16740 DEPENDENCE OF SHOCK STRUCTURE AT VENUS AND MARS ON ORIENTATION OF THE INTERPLANETARY MAG-

NETIC FIELD. Greenstadt, E. W. (TRW Systems Group, Redondo Beach, Calif.). Cosmic Electrodyn.; 1: 380-8(Dec 1970).

Magnetic events detected by Mariners 5 and 4 signified the probable presence of magnetosheaths surrounding Venus and Mars. Re-examination of the data at the boundaries of these planetary sheaths shows that the nature of the boundaries was correlated with the orientation of the interplanetary field B in the solar wind. If the boundaries are represented by the usual hydromagnetic shocks, and cross sections of the shocks are examined in planes formed by B and the Sun-to-planet lines (solar ecliptic X-axes), then well-defined field jumps were associated with interplanetary fields locally tangent to the cross sections, while fluctuating fields and gradual changes in mean level were associated with interplanetary fields more nearly normal to the cross sections. These associations between field alignment and character of the boundary conform to a recently proposed model of the Earth's bow shock. (auth)

16741 POTASSIUM–URANIUM SYSTEMATICS OF APOLLO 11 AND APOLLO 12 SAMPLES: IMPLICATIONS FOR LUNAR MATERIAL HISTORY. Fanale, Fraser P.; Nash, Douglas B. (California Inst. of Tech., Pasadena). Science; 171: 282-4 (22 Jan 1971).

Apollo 11 and Apollo 12 lunar rock suites differ in their potassium–uranium abundance systematics. This difference indicates that relatively little exchange of regolith material has occurred between Mare Tranquillitatis and Oceanus Procellarum. The two suites appear to have been derived from materials of identical potassium and uranium content. It appears unlikely that bulk lunar material has the ratio of potassium to uranium found in chondrites. However, systematic differences in the potassium–uranium ratio between Apollo samples and crustal rocks of the Earth do not preclude a common potassium–uranium ratio for bulk Earth and lunar material. (auth)

16742 CARBON, CARBIDES, AND METHANE IN AN APOLLO 12 SAMPLE. Chang, Sherwood (Ames Research Center, Moffett Field, Calif.); Kvenvolden, Keith; Lawless, James; Ponnamperuma, Cyril; Kaplan, I. R. Science; 171: 474-7(5 Feb 1971).

Total carbon in the Apollo 12 sample 12023 fines was 110 micrograms per gram of sample with a carbon isotopic abundance $\delta^{13}C$ (relative to the Pee Dee belemnite standard) of +12 per mil. Hydrolysis of the fines with deuterium chloride yielded undeuterated methane along with deuterated hydrocarbons, thus confining the presence of 7 to 21 micrograms of carbon per gram of sample as carbide and about 2 micrograms of carbon per gram of sample as indigenous methane. After vacuum pyrolysis of the fines to 1100°C the following gases were detected in the relative abundance: carbon monoxide $\gg$ carbon dioxide > methane. Variations of the $\delta^{13}C$ value with the pyrolysis temperature indicated the presence of carbon with more than one range of isotopic values. The observed $\delta^{13}C$ value of +14 per mil for lunar carbide is much higher than that of carbide in meteorites. These results suggest that lunar carbide is either indigenous to the Moon or a meteoritic contribution that has been highly fractionated isotopically. (auth)

16743 CIRCULAR-POLARIZATION AND TOTAL-FLUX MEASUREMENTS OF JUPITER AT 13.1-cm WAVELENGTH. Gulkis, S.; Gary, B. (Jet Propulsion Lab., Pasadena, Calif.). Astron. J.; 76: 12-16(Feb 1971).

Circular-polarization and total-flux measurements of Jupiter at a wavelength of 13.1 cm were made during April and May of 1969 with the 210-ft radio telescope at Goldstone, California. An upper limit to the net degree of circular polarization of 1% was established over the longitude range of the observations, 10 to 100° and 160 to 250° System III (1957.0). Total flux data have been used to derive a magnetosphere rotation period of 09h 55m 29.72 ± 0.11s, which is 0.35 sec longer than the standard IAU System III (1957.0). The total flux data define a beaming curve which has north–south symmetry about the magnetic equator, whereas the beaming curve produced from 1964 observations shows an asymmetry. (auth)

16744 LUNAR STONES AND NUCLEAR PHYSICS. Bernas, R. (CNRS, Orsay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.46-51(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Using radioactive dating methods the age of the crystalline lunar rocks is estimated to be 3.6×10^9 years, and that of the lunar dust 4.5×10^9 years. Particles and radiations of solar or cosmic origin that have bombarded the lunar surface were studied. Two experimental approaches were adopted: the examination of tracks produced in the insulating solids contained in the lunar rocks and the quantities of stable or radioactive isotopes produced by the radiations, and trapped at the rock surface. (France)

16745 VARIATION OF SOURCE A POSITION OF THE JOVIAN DECAMETRIC RADIATION. Goertz, C. K. (Rhodes Univ., Grahamstown, South Africa). Nature (London). Phys. Sci.; 229: 151-2(1 Feb 1971).

The explanation of the observed correlation between source-A position in the system III (1967) with the change in Jovicentric declination of the Earth (D_E) by a theoretical model involving a beaming of the radiation into sheet (Donican et al., Astrophys J. Lett., 157: L65(1969)) is discussed. An alternative model is suggested by which the observed variation of the source-A position should be divided into a variation of Io-controlled A source and non-Io-controlled A source. An analysis of the Boulder data 1961-1966 supports this suggestion. The Io-controlled radiation is generated close to the planet surface on field lines passing through Io, and non-Io-controlled radiation is generated in the vicinity of the planet on field lines making an angle of 18° with the direction of rotation of Jupiter. To explain the variation of the non-Io-controlled source-A position, a mechanism capable of supplying electron streams is necessary, and possibilities are discussed. (UK)

16746 MILLIMETER WAVE SPECTRUM OF SATURN. Wrixon, G. T.; Welch, W. J. (Univ. of California, Berkeley). Icarus; 13: 163-72(Sep 1970).

Measurements of the disk brightness temperature of Saturn at six frequencies between 19 and 36 GHz are presented. The measured spectrum shows characteristics of absorption by the 23.7-GHz inversion band of ammonia. There is, in particular, a distinct minimum in the spectrum at 23.7 GHz. The observations agree well, both in terms of band shape and absolute intensity, with theoretical spectra of Saturn computed on the basis of an atmosphere that is fully saturated with ammonia near the cloud tops and whose effective radiating temperature is 100°K. (auth)

16747 MAGNETOSPHERES OF JUPITER AND EARTH. Brice, Neil M.; Ioannidis, George A. (Cornell Univ., Ithaca, N. Y.). Icarus; 13: 173-83(Sep 1970).

The magnetic fields of Earth and Jupiter carve cavities out of the solar wind, which in turn influences the dynamics and structure within the magnetospheres of these planets. From a knowledge of the factors that influence the terrestrial magnetosphere, expectations for the Jovian magnetosphere are deduced. The shape of the Jovian magnetosphere should be similar to that of Earth, with the size of the magnetosphere slightly larger relative to the size of the planet and the size of the auroral zone slightly smaller. The fraction of the incident solar-wind energy injected into the magnetosphere should be comparable for Earth and Jupiter. Major dissimilarities may occur because of the following fundamental differences: (1) the solar-wind-induced plasma flow should be smaller than the corotational flow essentially throughout the Jovian magnetosphere; (2) the centrifugal and gravitational forces balance at a point well within the region of Jupiter's magnetosphere dominated by corotation; (3) drift periods for energetic particles trapped in the magnetosphere are generally smaller than the rotation period for Earth, but much much larger for Jupiter; and (4) in the polar-cap regions of Earth, energy deposition into the ionosphere from the solar wind and solar euv radiation are comparable, but for Jupiter's polar-cap ionosphere, the solar-wind input should be clearly dominant. (auth)

16748 GEGENSCHEIN AND INTERPLANETARY DUST OUTSIDE THE EARTH'S ORBIT. Roosen, Robert G. (Goddard Space Flight Center, Greenbelt, Md.). Icarus; 13: 184-201 (Sep 1970).

The gegenschein has been observed in a four-year program, including photographic observations and high-resolution photoelectric scans. The results of these observations are interpreted with the help of model calculations that theoretically consider (1) the apparent phase function of the particles producing the gegenschein; (2) the distribution of these particles with respect to distance from the Earth and the Sun; and (3) the effect of the Earth's shadow on the illumination of these particles. All previous explanations for the gegenschein found in the literature are considered; the only one found tenable is that the gegenschein is caused by light reflected from particles of dust in heliocentric orbits. Further, models for the zodiacal light that assume that the spatial distribution of particles follows an inverse power law R^{-P} (where R is heliocentric distance and $P \geq 0$) cannot satisfactorily explain the gegenschein. There must be an increase in the spatial density of reflecting cross section (and hence presumably of reflecting material) outside the Earth's orbit. The asteroid belt is suggested as the source of the material. (auth)

16749 LUNAR ATOMIC HYDROGEN AND ITS POSSIBLE DETECTION BY SCATTERED LYMAN-α RADIATION. Gott III, J. Richard; Potter, A. E. Jr.). Manned Spacecraft Center, Houston, Tex.). Icarus; 13: 202-6(Sep 1970).

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Hydrogen from solar-wind proton bombardment is embedded in the lunar surface. It is suggested that sputtering by the solar wind returns the embedded atoms to space. The density of a hydrogen atmosphere formed in this way is calculated. It is shown that detection of the predicted atmosphere is possible by measurements of Lyman-α radiation intensity near the Moon. (auth)

Atomic and Molecular Physics

Refer also to abstracts 15973–15976, 17351, and 17638.

16750 BEAM–FOIL SPECTROSCOPY. Proceedings on the Second International Conference, Lysekil, Sweden, 7–12 June 1970. Martinson, I.; Bromander, J.; Berry, H. G. (eds.). Nucl. Instrum. Methods; 90: 1-371(1970). (CONF-700634).

Separate abstracts were prepared for 28 of the 55 papers presented. The remaining papers deal with techniques of beam–foil spectroscopy or with properties of elements not within the scope of NSA. (A.G.W.)

For abstracts of individual papers see: 15973–15976, 16693, 16754–16760, 16773–16778, 16807–16809, 16834–16836, 17149, 17150, 17637, and 17638.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 16188, 17213, 17264, and 17637.

16751 (NP-18640) CALCULATION OF THE PHASE-SHIFT OF AN ELECTRON BEAM SCATTERED BY A NICKEL ATOM. Technical Memorandum No. 110192. Leay, R. W. (British Petroleum Co. Ltd., Sunbury-on-Thames (England). Research Centre). 28 Aug 1970. 10p. Dep. NTIS (U. S. Sales Only).

The phase change of a beam of electrons scattered by a single nickel atom is calculated and tabulated for beam energies of 2 to 100 V. Only s-wave scattering is considered. This information was needed in studies of the behaviour of electrons at alloy surfaces. (auth) (UK)

16752 SPECTRAL ANALYSIS OF LIGHT EMITTED FROM METALLIC TARGETS BOMBARDED BY HIGH-ENERGY IONS. Terzic, I.; Perovic, B. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). Surface Sci.; 21: 86-98(Jun 1970).

Results of the spectral analysis of light emitted from Al, Mo, and Ag targets by bombardment with 40-keV Ar^+ ions are presented. Line spectra were detected, while continuous radiation was not observed. The effect of nonradiative processes near the surface on the character of the spectra obtained is discussed, and a model of the generation of an excited particle by binary collision between the incident ion and the surface atom is presented. (auth)

16753 SCATTERING OF DEUTERIUM MOLECULAR BEAMS FROM GRAPHITE OVERGROWTHS ON PLATINUM CRYSTALS. Merrill, Robert P.; Smith, Donald L. (Univ. of California, Berkeley). Surface Sci.; 21: 203-7(Jun 1970).

Surface layers of graphite were produced on Pt single crystals by heating for several hr at 600°C in vacuum at pressures below 10^{-9} torr. The scattering of deuterium from a clean surface of Pt (111) and a (111) surface prepared as above were studied; the scattering from the graphite-covered surface is much broader than from the clean surface, has a peak maximum about 5° subspecular, and is symmetric. The LEED patterns of the surface are characteristic of graphite overlayers. The scattering peak is compared with those for helium scattering from Ni and for deuterium from amorphous C on Pt. (D.L.C.)

16754 SPECTROSCOPIC TECHNIQUES FOR STUDYING THE BEAM–FOIL INTERACTION. Berry, H. G.; Bromander, J.; Buchta, R. (Research Inst. for Physics, Stockholm). Nucl. Instrum. Methods; 90: 269-74(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

Possible experiments to study the beam–foil interaction mechanism are discussed. Shell effects are observed when relative intensities of beam spectra are compared with charge-state fractions as a function of beam energy. Only small changes are found in relative intensities within the same charge state, except for transitions from doubly excited states. Comparisons with unidentified transitions have helped in classifying some new excited states. The production mechanisms for doubly excited states and ejected excited foil atoms are discussed. Relative intensities of beam spectra are found to vary with foil type. Comparisons with sputtering experiments indicate that the interaction with the final surface atoms of the foil is important in producing the observed excitation distributions. (auth)

16755 ANGULAR DISTRIBUTIONS OF IONS SCATTERED IN THIN CARBON FOILS. Hoegberg, G.; Norden, H. (Chalmers Univ. of Tech., Goteborg). Nucl. Instrum. Methods; 90: 283-8 (1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

The energy loss and scattering distributions of energetic light particles transmitted through thin carbon foils are determined. The dependence of the energy loss on the scattering angle is reported for 40-keV nitrogen ions in a carbon foil 5.7 $\mu g/cm^2$ thick. The angular halfwidths are reported for H, He, Li, N, Ne, and Ar ions from 3 to 54 keV. A very simple empirical relation is established for the angular halfwidths of ions scattered in thin carbon foils in terms of their mean energy and atomic number and of the foil thickness. The experimental angular distributions and their halfwidths are compared with the new Meyer theory on plural and multiple scattering of ions in amorphous targets. The agreement is shown to be good. (auth)

16756 FOIL-EXCITATION MECHANISMS. Garcia, J. D. (Univ. of Arizona, Tucson). Nucl. Instrum. Methods; 90: 295-8 (1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

Some mechanisms related to the excitation of atoms passing through foils are discussed. Simple models simulating these mechanisms are constructed, and calculations are performed in an attempt to gain qualitative understanding of the excitation process. Though no single model has been found to provide a reasonable guide to this complex problem, some qualitative relationships not in disagreement with experiment emerge. The energy dependence of electron capture by protons in a foil follows a E_p^{-5} law at higher energies, consistent with recombination in streaming plasmas. The role of inner-shell processes is also discussed. (auth)

16757 MULTICOLLISIONAL MOLECULAR ORBITAL MODEL FOR THE BEAM–FOIL INTERACTION PROCESS. Bickel, W. S.; Jensen, K.; Newton, C. S.; Veje, E. (Univ. of Copenhagen). Nucl. Instrum. Methods; 90: 309-14(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

Excitation functions for helium levels excited with a carbon foil are compared with those excited by a single-collision ion–atom interaction. A model for the beam–foil interaction process is proposed, which applies theoretical and experimental results from ion–atom collisions to beam–foil collision data. It is shown that in many respects, the ion–atom and beam–foil interactions are similar. The significant difference is the complication introduced by the high-density foil material, which effectively causes effects such as excitation functions, sputtering, and spectra to appear as gross features averaged over many unrelated collisions. (auth)

16758 EQUILIBRIUM CHARGE DISTRIBUTIONS OF ION BEAMS IN CARBON. Hvelplund, P.; Laegsgard, E.; Olsen, J. O.; Pedersen, E. H. (Univ. of Aarhus, Denmark). Nucl. Instrum. Methods; 90: 315-20(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

The equilibrium charge fractions were measured for beams of N, O, F, Ne, Na, Mg, Al, and Ar in the energy range from 100 to 500 kev and for beams of Tl in the energy range from 200 to 1100 keV. The ions under investigation were sent through thin (5 to 10 $\mu g/cm^2$) carbon foils, and the emerging beam was separated electrostatically and detected by an open position-sensitive electron multiplier. Corrections were made for energy loss in the carbon foils by means of measured electronic and theoretical nuclear stopping cross sections for the forward-directed beam. The beam was accepted by a small (0.3-mm diameter) aperture in front of the deflection plates. For Tl, the corrections for energy loss were calculated from the theoretical value of the electronic stopping cross section and the nuclear stopping cross section for the forward-directed beam. The main purpose of the present work was to investigate the variation in charge-state population for atoms around Ne because shell effects are expected to drastically influence the charge distributions. For example, the neutral fractions at 10 keV/amu are 37% for Ne, 10% for Na, and 3% for Mg. Preliminary measurements of charge-state fractions for Tl are reported. (auth)

16759 SOME MEASUREMENTS OF INNER-SHELL-VACANCY PRODUCTION BY HEAVY-ION BOMBARDMENT. Mokler, P. H.; Lutz, H. O.; Stein, H. J.; Armbruster, P. (Kernforschungsanlage, Julich, Ger.). Nucl. Instrum. Methods; 90: 321-4(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

XUM

Thin targets of Yb, Te, and Mo were bombarded with 30-MeV I−ions and the characteristic L and M radiation was studied for both colliding particles. First, the impact-parameter dependence of inner-shell-vacancy production was investigated in a I−Te system. The characteristic impact parameters are comparable to the shell radii. Second, the energy structure of the emitted x rays was analyzed by a high-resolution Si(Li) detector. The characteristic x rays are shifted to higher energies. (auth)

16760 PENETRATION OF 1- TO 20-keV IONS THROUGH THIN CARBON FOILS. Bernstein, W.; Cole, A. J.; Wax, R. L. (TRW Systems, Redondo Beach, Calif.). Nucl. Instrum. Methods; 90: 325-8(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

The penetration of 1- to 20-keV H^+, D^+, He^+, Li^+, N^+, Ne^+, and K^+ ions through carbon foils of nominally 2 $\mu g/cm^2$ thickness was studied experimentally. The observed energy loss for these ions is approximately proportional to the product of the incident ion velocity and the ion atomic number ($Z_1 v_1$). The energy loss does not show a dependence on scattering angle. The measured angular width of particles scattered by the foil is observed to be approximately proportional to Z_1/E_1 where E_1 is the incident ion-energy. From these results it is concluded that effects due to nuclear collisions are not significant in the energy and atomic-number range under study. (auth)

16761 MICROWAVE-DISCHARGE ION SOURCE FOR CHEMICAL ACCELERATOR. Okamoto, Yukio (Nagoya Univ., Japan); Tamagawa, Hajime. Jap. J. Appl. Phys.; 10: 165-6(Jan 1971).

A simple microwave-discharge plasma ion source for chemical-accelerator applications is described. The source is capable of producing high-quality ion beams of 1 μA at 100 eV for Ar^+ ions. The energy dispersion of the ions is 0.3 eV. With higher input of rf power (up to 200 W), the source can be used to produce multiply charged ions. (A.G.W.)

16762 PRECISE TEST OF THE Z^2 DEPENDENCE OF X-RAY EMISSION INDUCED BY α PARTICLES AND DEUTERONS. Lewis, C. W.; Natowitz, J. B.; Watson, R. L. (Texas A and M Univ., College Station). Phys. Rev. Lett.; 26: 481-4(1 Mar 1971).

The ratios of x-ray yields from the irradiation of Ti, Cu, and Au targets with α particles and deuterons of identical velocities were determined between 6.25 and 20 MeV/amu. At the lowest velocities the data from K x rays from Ti and Cu indicate deviations as large as 12% from the theoretical ratios calculated according to the Born approximation. No significant deviation is observed for L x rays from Au. (auth)

16763 INTENSITY DATA FOR THE REFLECTION AND DIFFRACTION OF ^3He, ^4He, H_2, AND D_2 FROM THE (001) SURFACE OF LiF. O'Keefe, D. R.; Smith, Joe N. Jr.; Palmer, R. L.; Saltsburg, Howard (Gulf General Atomic Inc., San Diego, Calif.). Surface Sci.; 20: 27-43(Mar 1970).

Intensity data from the reflection and diffraction of incident thermal beams of ^3He, ^4He, H_2, and D_2 from the (001) surface of LiF are presented and compared with a recent theory of diffraction. Particular emphasis is placed on the variation of the intensity of the specular beam with angle of incidence, incident-beam temperature, and azimuthal orientation. Also reported are intensity data for the resolved diffracted beams both in and out of the plane of incidence. Qualitative agreement is found to exist between theory and experiment for many of the intensity variations studied. Lack of total agreement is probably due to the inadequacy of the theory in not considering inelastic processes and the failure to account for the particles in the beams which would theoretically be diffracted into the surface but which physically must leave the surface as part of the scattered background. Also to be considered is the large discrepancy between values of the bound energy states for ^3He used in the theory and those measured experimentally. Any comparison of H_2 or D_2 scattering with the theory is seriously in doubt because of the contribution of inelastic scattering due to rotational energy state coupling of the diatomic molecules with the surface. (auth)

16764 BASE OF MULTIPLE COMPONENT SYSTEM ANALYSIS BY ELECTRON AND BETA RAY INTERACTION. II. EXPERIMENTAL STUDIES OF THE EFFECTIVE ATOMIC NUMBER FOR THE BACKSCATTERING PROCESS. Thuemmel, H. W. (Inst. fuer Angewandte Radioaktivitaet, Leipzig). Isotopenpraxis; 6: 254-60(Aug 1970). (In German).

Measurements on lead compounds and substances containing hydrogen with β rays in the energy range from 0.2 to 3 MeV show that the effective-atomic-number formula derived in part I is correct even for media of extreme composition. Discrepancies between the calculated atomic numbers and experimental results mentioned in literature are mainly due to differences in probe density and partly also due to probe grain. In this work such disturbances are avoided by appropriate choice of the measuring conditions or eliminated by empirical correction. (auth)

16765 DELAYED PHOTON EMISSION FROM ALPHA-EXCITED SOLID HELIUM. Manning, R. J.; Agee, F. J. Jr.; Vinson, J. S.; Hereford, F. L. (Univ. of Virginia, Charlottesville). Phys. Lett.; 33A: 485-6(28 Dec 1970).

Delayed photon emission (t > 30 μsec) was observed following the prompt scintillation pulses produced by α particles bombarding solid helium. It is thought to originate from excitons of the type proposed by Packard, Reif, and Surko to account for a narrow emission line in solid neon. (auth)

16766 OPTICAL RADIATION FROM LOW-ENERGY ION–SURFACE COLLISIONS. White, C. W.; Tolk, N. H. (Bell Telephone Labs., Whippany, N. J.). Phys. Rev. Lett.; 26: 486-9 (1 Mar 1971).

Low-energy ion–surface collisions were observed to result in the emission of optical radiation arising from sputtering with simultaneous excitation. Emission functions were obtained showing structure and energy thresholds that provide detailed information important in the understanding of this low-energy phenomenon. These data can be understood in terms of excited-state sputtering efficiencies and radiationless de-excitation processes, which compete with radiative de-excitation of the excited states of the sputtered atoms. (auth)

16767 RECENT STUDY ON THE ELECTRON-BOMBARDMENT-INDUCED EMISSION OF IONS FROM SOLID SURFACES. Nishijima, Mitsuaki (Mitsubishi Electric Corp., Amagasaki, Japan). Shinku; 13: 159-70(May 1970). (In Japanese).

The interactions of particle beams with solid surfaces have been studied actively. The electron-bombardment-induced emission of ions from a solid surface was first observed by Dempster. Redhead and Menzel and Gomer demonstrated that this method is a powerful means to study the interaction of a solid surface with a gas. In this method, since a very small current is used as a probe and since high voltage is not applied to the solid surface, the state of the samples is not influenced by the probe. Furthermore interpretation of the experimental result is easier than interpretation of LEED results. In this report, first, the recent studies on this subject are reviewed in some detail. Second, a cylindrical magnetic spectrometer is explained. Third, the mechanism for the electron-bombardment-induced emission of ions is described. Finally, the kinetics of the electron-bombardment-induced emission of gases is described. (Japan)

Atomic and Molecular Properties

Refer also to abstracts 16694, 16713, 17136, 17162, and 17299.

16768 (TID-25596) A MEASUREMENT OF THE $2^2S_{\frac{1}{2}}-2^2P_{\frac{1}{2}}$ ENERGY SEPARATION (Δ E−S), AND THE $2^2S_{\frac{1}{2}}-2^2P_{\frac{3}{2}}$ ENERGY SEPARATION(S), IN HYDROGEN (n = 2); A STUDY OF A RESOLVED PERIODIC-VELOCITY PRODUCING TRANSITION BETWEEN THE HYPERFINE COMPONENTS OF THE $2^2S_{\frac{1}{2}}$ STATES. Rebane, Toomas (Michigan Univ., Ann Arbor). 1970. 139p. Dep. NTIS.

Thesis.

The $2S_{\frac{1}{2}}-2P_{\frac{1}{2}}$ energy separation (ΔE−S) and the $2S_{\frac{1}{2}}-2P_{\frac{3}{2}}$ energy separation (S) were measured in the n = 2 state of atomic hydrogen by an atomic-beam radio-frequency method. A beam of metastable atoms in the single hyperfine state β_A (F = 0, m_F = 0) was used. The electric dipole transitions β_A−b (F = 1, m_F = 1), β_A−d (F = 1, m_F = −1) (ΔE−S interval), and β_A−e (F = 1, m_F = 1) (S interval) were observed at fixed frequencies by sweeping the Zeeman magnetic field parallel to the beam axis. The latter transition was observed at two widely separated magnetic fields. Measurements of the frequencies of the rf field used to drive the transitions and the magnetic fields at the line centers of the resonance curves were used together with the theory of Zeeman splitting to determine the zero-field splittings (ΔE−S and S). The calculation was carried out numerically by highly accurate diagonalization of the energy hamiltonian. The final values are (ΔE−S) = 9911.250 ± 0.063 MHz and S = 1057.72 ± 0.34 MHz, where the quoted uncertainty is one average deviation from the mean. Combining these two intervals yields ΔE = 10968.97 ± 0.35. The corresponding value for α^{-1} is 137.0363 ± 0.0022. Only the β_A component of the metastable beam was used because of the discovery of a novel resolved periodic-velocity distribution of the regenerated β_B component. The experimental results of this distribution are fitted to a two-parameter theory. (auth)

16769 DOUBLE RESONANCE INVESTIGATION IN EXCITED STATES OF Lu I. Goebel, L. H. (Technische Univ., Berlin). Z. Naturforsch.; 25a: 1401-5(Oct 1970). (In German).

XUM

In a double resonance experiment the g_J factor of the excited state of Lu I $5d6s6p\ (^1D)\ ^3D_3$ was measured: $g_J\{(^1D)\ ^2D_{\frac{3}{2}}\} = 0.874$ (5). This value deviates considerably from its value in Russel–Saunders coupling. The lifetime of this state is $(4.8 \pm 0.10) \times 10^{-8}$ sec. (auth)

16770 GROUND STATE OF THE TERBIUM ATOM. Klinkenberg, P. F. A.; Van Kleef, Th. A. M. (Univ., Amsterdam). Physica; 50: 625-8(31 Dec 1970).

From the optical spectrum of free Tb atoms and the Zeeman effect of a few transitions it is proven that the ground state is $4f^96s^2\ ^6H^0_{\frac{15}{2}}$, which is at 285.580 cm^{-1} below $4f^85d6s^2\ ^8G_{\frac{17}{2}}$, the lowest state known previously. (auth)

16771 HYPERFINE STRUCTURE, STARK EFFECT, AND LIFETIMES OF THE EXCITED 5d6s6p y $^2D_{\frac{3}{2},\frac{5}{2}}$ STATES OF THE LANTHANUM I SPECTRUM. Hese, A.; Bueldt, G. (Technische Univ., Berlin). Z. Naturforsch.; 25a: 1537-45(Nov 1970). (In German).

The level-crossing method was used for an investigation of the hyperfine structure and lifetimes of the excited 5d6s6p y $^2D_{\frac{3}{2},\frac{5}{2}}$ states of La I. From a detailed analysis of the measured change in intensity of the resonance light, the following hyperfine interaction constants and lifetimes were deduced: for 5d6s6p y $^2D_{\frac{3}{2}}$, $A = +143.18 \pm 0.11$ ($G_J/0.802$) MHz, $B = +1.27 \pm 0.37$ MHz, and $\tau = 14.2 \pm 0.09$ nsec; for 5d6s6p y $^2D_{\frac{5}{2}}$, $A = +63.41 \pm 0.21$ ($G_J/1.186$) MHz, $B = -13.3 \pm 0.14$ MHz, and $\tau = 15.2 \pm 0.10$ nsec. By applying an additional homogeneous electric field parallel to the usual magnetic field the constants β of the quadratic Stark effect in the y ^2D states were derived from the observed shifts of the level-crossing signals: $\beta(y\ ^2D_{\frac{3}{2}}) = +0.095 \pm 0.017$ MHz/(kV/cm)^2 and $\beta(y\ ^2D_{\frac{5}{2}}) = -0.0075 \pm 0.0025$ MHz/(kV/cm)^2. The experimental results are interpreted theoretically by the concept of intermediate coupling using appropriate eigenvectors. The observed lifetimes and the β values are compared with the Bates and Damgaard approximation. (auth)

16772 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 5, NO. 11, 1970. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 72p.

A listing is presented of 319 articles on various aspects of surface and vacuum physics. (M.O.W.)

16773 ATOMIC SPECTRA; REFERENCES TO ANALYSES OF ATOMIC SPECTRA; A CRITICAL COMPILATION AS OF JUNE 1970. Edlen, B. (Univ. of Lund, Sweden). Nucl. Instrum. Methods; 90: 1-2(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

A condensed up-to-date list of references to term analyses involving the elements $Z \leq 23$ is presented. (auth)

16774 ATOMIC TRANSITION PROBABILITIES: A SURVEY OF OUR PRESENT KNOWLEDGE AND FUTURE NEEDS. Wiese, W. L. (National Bureau of Standards, Washington, D. C.). Nucl. Instrum. Methods; 90: 25-33(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

A general survey of the present status of our knowledge of atomic transition probabilities is given, and the principal methods for obtaining the numerical data are briefly reviewed on a critical basis. Areas of particular relevance to beam–foil spectroscopy are emphasized. Some general problems encountered with beam–foil data are pointed out. Finally, some of the most pressing future needs for new and improved transition probabilities are indicated. (auth)

16775 LIFETIME MEASUREMENTS BY AN ELECTRON–PHOTON COINCIDENCE METHOD. Imhof, R. E.; Read, F. H. (Univ. of Manchester, Eng.). Nucl. Instrum. Methods; 90: 109-13(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

A new method is described for determining neutral atomic and molecular lifetimes by measuring delayed coincidences between inelastically scattered electrons and the subsequent decay photons. The method has been applied to three states in helium ($3\ ^3D$, $4\ ^3S$, and $4\ ^1S$), to the $C\ ^3\Pi_u$ state in nitrogen, and to the $a\ ^3\Sigma_g^+$ state in hydrogen. Apart from the $4\ ^1S$ lifetime, all the above measurements are thought to be free from cascade and other systematic errors. (auth)

16776 EVALUATION OF RELATIVISTIC AND RADIATIVE CORRECTIONS TO THE ENERGY OF TWO-ELECTRON ATOMIC STATES. Aashamar, K. (Univ. of Oslo). Nucl. Instrum. Methods; 90: 263-8(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

Hylleraas–Scherr–Knight variational perturbation wave functions, known through 20th perturbation order, were used to evaluate, in the form of power series expansions in Z^{-1}, the lowest-order relativistic and radiative corrections to the energy of the two-electron atomic states $(1s)^2\ ^1S$ and $(2p)^2\ ^3P$. The mass polarization correction, which contributes to the same order of magnitude, was determined as well. The total theoretical energies are tabulated for the first 10 elements of the helium isoelectronic sequence, and the values are compared with available experimental results. (auth)

16777 RESONANCE EFFECT OF FAST MOVING EXCITED ATOMS BY SPATIALLY PERIODIC POTENTIALS. Hadeishi, T. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 90: 337-41(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

Resonance effects of the fast-moving excited atoms from an accelerator, propagating through a spatially periodic potential, are described experimentally and theoretically. Atoms or ions propagating through the spatially periodic potential (or field) at the velocity V experience an oscillating frequency ν given by $\nu = V/(2d)$, where 2d is the period of the spatial potential. Thus the resonance effect ranging from rf to microwave frequency can be observed. In addition to the phenomena already observed, some new proposals concerning the magnetic resonance by a spatially periodic magnetic potential are given. (auth)

16778 QUANTUM BEATS AND LEVEL CROSSING AFTER BEAM–FOIL EXCITATION. Andra, H. J. (Freie Univ., Berlin). Nucl. Instrum. Methods; 90: 343-9(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

The theory of light emission due to the decay of a coherent superposition of states to some lower state is outlined, with special emphasis on a coherently excited two-level system. With foil excitation several types of coherence have to be considered. The effects of these are demonstrated with quantum-beat measurements in electromagnetic and zero fields in H and He emission: (a) foil-, (b) electric-field-, and (c) magnetic-field-induced coherence. The information carried about the initial wave functions by the beat amplitudes and phases is discussed for each case, with main interest in the production of alignment of M_L states. Based on these considerations, the determination of fine-structure and hfs separations with quantum-beat, magnetic-resonance, and level-crossing measurements is possible. With the derivation of the formula for the level-crossing signal, it is shown that this observation method is not sensitive to beam velocity uncertainties and is therefore well suited for precision measurements on ions after beam–foil excitation. The observation of level crossing and the Hanle effect in He emission is reported. (auth)

16779 EVALUATION OF THE EFFECTIVE NUCLEAR CHARGES FROM THE IONIZATION POTENTIALS OF ATOMS. Goerlich, Edward. Zesz. Nauk. Akad. Gorn.-Hutn. Krakow., Rozpr.; 207: No. 1, 87-96(1969). (In Polish).

The importance of the concept of the effective nuclear charge in inorganic chemistry is stressed and the semi-empirical methods used for its evaluation are briefly reviewed. As none of these methods can be regarded as final, a new method of approach is tried, based on the ionization potentials of atoms. The method proposed is simple, accurate and contains, as a special case, the possibility of determination of the atomic number of elements from ionization potentials. (auth)

16780 SPECTRUM OF THE CN MOLECULE. II. $F^2\Delta_r - A^2\Pi_i$. Lutz, Barry L. (National Research Council of Canada, Ottawa). Astrophys. J.; 164: 213-16(15 Feb 1971).

The 1–6, 2–7, 1–7, and 2–8 emission bands of the $F^2\Delta_r - A^2\Pi_i$ transition of CN were analyzed under high resolution. The following molecular constants were determined for the $F^2\Delta_r$ state (cm^{-1}): $T_e = 60095.64$, $B_e = 1.3834$, $\alpha_e = 0.0187$, $D_e = 7 \times 10^{-6}$, $\omega_e = 1239.50$, $\omega_e x_e = 12.75$. Some new band heads of the $E^2\Sigma^+ - A^2\Pi_i$ system are reported. (auth)

16781 EXACT ANALYTIC EVALUATION OF THE H_2^+ FORCE CONSTANT. Katriel, J.; Adam, G. (Nuclear Research Centre, Beer-Sheva, Israel). Chem. Phys. Lett.; 8: 191-4(15 Jan 1971).

An analytic approach to the calculation of the H_2^+ force constant is presented. The method is based on the use of the virial theorem. (auth)

16782 REDUCED-PARTITIONING TECHNIQUE FOR CONFIGURATION-INTERACTION CALCULATIONS USING PADE APPROXIMANTS AND INNER PROJECTIONS. Braendas, E. J.;

XUM

Bartlett, R. J. (Univ. of Florida, Gainesville). Chem. Phys. Lett.; 8: 153-6(15 Jan 1971).

A perturbation procedure for arbitrary many-electron systems, which incorporates Padé approximants and inner projections, was developed within the configuration-interaction framework. The method is illustrated by an application to the hydrogen molecule. (auth)

16783 RADIOFREQUENCY SPECTROSCOPY OF HYDROGEN FINE STRUCTURE IN n = 3,4,5. Fabjan, C. W.; Pipkin, F. M.; Silverman, M. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett.; 26: 347-50(15 Feb 1971).

All of the fine-structure intervals in the hydrogen n = 3,4 manifolds and all but the F−G transitions in n = 5 were measured using radiofrequency spectroscopy on a fast hydrogen beam. The experimental results are in agreement with theoretical predictions. (auth)

16784 STARK BROADENING OF H_β, H_γ, AND H_δ: A COMPARISON OF THEORY AND EXPERIMENT. Hill, R. A. (Sandia Labs., Albuquerque, N. Mex.); Gerardo, J. B.; Kepple, Paul C. Phys. Rev., A; 3: 855-62(Mar 1971).

A precision comparison is made between the Stark-broadened profiles of H_β, H_γ, and H_δ measured by Hill and Gerardo and the theoretical profiles calculated by Kepple and Griem. In addition, the effects of inelastic collisions between perturbing electrons and the radiating atom are investigated. It is found that the inclusion of the inelastic collisions improves the qualitative agreement between theory and experiment near the line center, but that the Gaunt factors used to estimate the broadening strength of the inelastic collisions overestimate the effect. In terms of half-widths, the best comparison to experiment was obtained using theoretical profiles that omitted inelastic collisions. The electron densities determined from these profiles are 2, 3, and 6% less than the interferometric values of H_β, H_γ, and H_δ, respectively. (auth)

16785 FINE-STRUCTURE MEASUREMENT OF SINGLY IONIZED HELIUM, n = 4. Jacobs, Ralph R.; Lea, Kenneth R.; Lamb, Willis E. Jr. (Yale Univ., New Haven). Phys. Rev., A; 3: 884-905(Mar 1971).

Precision measurements of the energy differences $\mathscr{I}_4(4^2S_{\frac{1}{2}} - 4^2P_{\frac{1}{2}})$ and $\Delta E_4 - \mathscr{I}_4(4^2P_{\frac{3}{2}} - 4^2S_{\frac{1}{2}})$ in $(He^4)^+$ are reported. The experimental results, $\mathscr{I}_4 = 1768 \pm 5$ MHz and $\Delta E_4 - \mathscr{I}_4 = 20\,179.7 \pm 1.2$ MHz, agree with the values predicted by quantum electrodynamic theory, $\mathscr{I}_4 = 1768.34 \pm 0.51$ MHz and $\Delta E_4 - \mathscr{I}_4 = 20\,180.78 \pm 0.56$ MHz. An electron gun excites the states of interest in a section of waveguide containing helium gas. A magnetic field applied perpendicular to the waveguide axis is used to scan a microwave resonance between suitable Zeeman levels for a fixed frequency of oscillating electric field in the waveguide. Any induced electric dipole transitions $4^2S_{\frac{1}{2}} \rightarrow 4^2P_{\frac{1}{2}}$ or $4^2S_{\frac{1}{2}} \rightarrow 4^2P_{\frac{3}{2}}$ reduce the intensity of 1215-Å radiation emitted in the natural decay of 4S or 2P. This light is directed onto an ultraviolet-detecting phototube whose output is measured by a lock-in detector for which the synchronous signal is provided by square-wave amplitude modulation of the microwave field. The resonances obtained by varying the magnetic field are fitted to a theoretical line-shape formula by a computerized least-squares program. The resulting best-fit parameters include either $\mathscr{I}_4$ or $\Delta E_4 - \mathscr{I}_4$, depending on the transition studied. Consideration is given to the dependence of the resonance center on the gun current, helium pressure, and microwave power level. (auth)

16786 EXPERIMENTAL DETERMINATION OF RELATIVE RADIATIVE DECAY RATES OF VACANCIES IN THE K SHELL. de Pinho, A. G. (Pontifica Univ. Catolica, Rio de Janeiro). Phys. Rev., A; 3: 905-8(Mar 1971).

A high-resolution Ge(Li) x-ray spectrometer was used for measuring relative radiative decay rates of vacancies in the K shell of the following atoms: Au, Hg, Tl, Pb, Bi, Rn, Ra, Th, and U. In the most favorable cases, the x rays following the filling of a K vacancy by L_{II}, L_{III}, M_{II}, M_{III}, M_{IV}, M_V, N_{II}, N_{III}, N_{IV-V}, and O_{II-III} electrons were observed and measured. The results were compared with recent relativistic calculations carried out by Scofield. (auth)

16787 MEASUREMENT OF IONIZATION GROWTH RATES IN H_2 AT HIGH E/p. Buffa, A.; Malesani, G.; Nalesso, G. F. (Univ., Padua). Phys. Rev., A; 3: 955-60(Mar 1971).

Ionization growth rates of hydrogen, in the range of E/p between 100 and 10,000 V/cm torr, are presented. They have been deduced from microwave measurements of electron densities in a ring-shaped discharge, produced by a uniform magnetic field linearly increasing in time. The experimental conditions are described and the meaning of the obtained data is discussed as well as compared with the more usual results in a straight uniform electric field. At $E/p \leq 1000$, the obtained values of β/p, where β is the ionization growth rate, increase with E/p and are in good agreement both with theory and earlier experiments. At $E/p > 2000$, on the contrary, β/p decreases with increasing E/p as suggested by theory, but not yet measured experimentally. The maximum of $\beta/p \simeq 1.3 \times 10^9$ sec torr^{-1} corresponds to $E/p \simeq 2000$. (auth)

16788 REPULSIVE POTENTIAL CURVES FROM MOLECULAR CONTINUUM−CONTINUUM EMISSION. III. $He_2(X\,^1\Sigma_g^+)$. Chow, Kwok-wing; Smith, Allan Laslett (Yale Univ., New Haven). J. Chem. Phys.; 54: 1556-62(15 Feb 1971).

A least-squares iterative procedure is developed for deducing a repulsive (lower) potential curve from a known attractive (upper) potential curve and the observed continuum−continuum emission spectrum. The RKR curve for the $A\,^1\Sigma_u^+$ state of He_2 is used in conjunction with the 600-Å band (A−X) data to determine that, for He_2 $(X\,^1\Sigma_g^+)$, $V(R) = (202 \pm 10)\exp(-3.88 \pm 0.05)$ R, $1.3 \leq R \leq 2.4$ Å. It is shown that the 600-Å bands of $^3He_2$ can be predicted from those of $^4He_2$ without knowing the potentials. The Hopfield intensity distribution was recalculated to show that comparison with experiment still is hampered by lack of an accurate electronic transition moment function. (auth)

16789 DETERMINATION OF THE FIELD-INTENSITY DEPENDENCE OF THE FIRST COEFFICIENT OF TOWNSEND IONIZATION FOR ATOMIC HYDROGEN BY THE MONTE CARLO METHOD. Bolotin, V. B.; Poshyunaite, N. P.; Fridlyand, L. Z.; Tokeris, G. E.; Bolotin, A. B. (Vilnyus State Univ., USSR. Saratov Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zavid., Fiz.; No. 8, 70-6(1970). (In Russian).

The Monte Carlo method was used for determining the relation $\alpha/p_0 = f(E/p_0)$ for atomic hydrogen within the limits of $E/p_0 = 10$ to 100 V/cm mm Hg. It was assumed that atomic excitation corresponding to transitions of 1 s electrons to 2 s or 2 p levels takes place along with elastic collisions and ionization. (tr-auth)

16790 P-STATE CONTINUUM FUNCTION AND THE ABSORPTION COEFFICIENT OF THE NEGATIVE HYDROGEN ION. Postma, R. (Univ. of Kentucky, Lexington). Astron. Astrophys.; 10: 213-19(Jan 1971).

By means of a partial separation of angles and the use of difference approximations, the Schroedinger wave equation for the negative hydrogen ion in the symmetric P-state is reduced to a system of linear algebraic equations. The system is solved numerically in a finite region, for a given energy and with asymptotic values on the boundary. The resultant wave function is used to calculate the absorption coefficients of the negative hydrogen ion for the wavelengths $\lambda = 8000$ Å and $\lambda = 12000$ Å. The results are then compared with the best previously calculated values. The values as determined from the dipole moment, momentum, and acceleration operators are compared, with special attention given the acceleration. These three ways of calculating the absorption coefficient are shown to agree quite well. It is thus shown that improvement of the continuum wave function plays a vital role in attempting to improve further the calculated absorption coefficient. (auth)

16791 ENERGY OF THE INTERACTION BETWEEN TWO ATOMS CALCULATED BY USING THE VARIATIONAL METHOD. Pecul, K. (Univ. of Warsaw). Acta Phys. Pol.; A39: 9-20(1971).

The reasons for the poor numerical accuracy in variational calculations of the interaction energy between two atoms are investigated. Some possibilities for improvement of that situation are presented. Some numerical results for the $^1\Sigma_g^+$ and $^3\Sigma_u^+$ states of the hydrogen molecule are given. (auth)

16792 PREDISSOCIATION OF THE H_2 $D^1\Pi_u$ STATE. Julienne, P. S. (National Bureau of Standards, Washington, D. C.). Chem. Phys. Lett.; 8: 27-8(1 Jan 1971).

The electronic nondiagonal Born−Oppenheimer coupling matrix elements between the molecular hydrogen $D^1\Pi_u$ state and the B' $^1\Sigma_u$ and $B\,^1\Sigma_u$ states were calculated in the Hartree−Fock approximation at R = 1.0, 1.2, 1.6 and 2.0 au. These were used to calculate the predissociation widths for the v = 3 to 12 levels of the D state with J = 1. The predissociation can only be caused by the B' state. The widths are around 1 cm^{-1}. (auth)

16793 HYPERFINE-STRUCTURE INVESTIGATIONS IN THE Tm I AND Eu I SPECTRUM USING A SPHERICAL FABRY-PEROT INTERFEROMETER AND AN INTERNAL ATOMIC BEAM. Kuhl, J. (Technische Univ., Hanover). Z. Phys.; 242: 66-85(1971). (In German).

A spherical Fabry−Perot spectrometer with an absorbing atomic beam passing the interior of the interferometer is described. By use of the internal beam it is possible to reduce the amount of material needed for the atomic-beam source to a few milligrams per hour. The set-up is especially suitable for hyperfine-structure

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and isotope-shift investigations. For the photoelectric recording of the signal, the geometrical distance between the spherical mirrors was changed using the piezoelectric effect. In order to reduce the influence of the intensity distribution of the light source $I_0(\lambda)$ the ratio $[I_0(\lambda) - I(\lambda)]/I_0(\lambda)$ was measured, where $I(\lambda) = I_0(\lambda) \exp(-V \cdot k(\lambda) \cdot d)$ is the observed intensity with absorbing atoms between the mirrors, and V the increase of the absorption signal due to the multiple reflections of the light through the atomic beam ($V \approx 75$). For an accurate and easy evaluation of the data this ratio was measured by a digital voltmeter and punched into paper tape. The small line width of the absorption profile obtained in the experiments with Tm and Eu made it possible to measure hyperfine distances of the order of 5×10^{-3} cm^{-1} to 20×10^{-3} cm^{-1} with an error not exceeding 0.1×10^{-3} cm^{-1} in some cases. From the measurements the A factors for five levels of the configurations $4f^{13}6s6p$ and $4f^{12}5d6s^2$ in Tm I and the A and B factors of the stable Eu isotopes of the $4f^76s6p\ y^8P_{5/2}$ level in Eu I were determined. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 17291 and 17315.

16794 (NYO-3661-34) NON-LINEAR LEAST SQUARES FIT TO MULTI-EXPONENTIAL COMPONENT CURVES: DATA REDUCTION PROGRAMS FOR POSITRON ANNIHILATION LIFETIME SPECTRA. Hyde, Marcia; Tao, S. J. (New England Inst., Inc., Ridgefield, Conn.). Nov 1970. 20p. Dep. NTIS.

This program is a package of four programs: (1) Phil 3—fit to three-exponential-component curve, (2) Mark 4B—fit to two-exponential-component curve, (3) Secf 3—fit to one-exponential-component curve, and (4) Slfsh—elimination of one of the exponential components from the experimental data. These four programs are under the supervision of a control program, Cont 3. (D.L.C.)

16795 MEASUREMENTS OF THE MOMENTUM CORRELATION IN THE THREE-PHONON ANNIHILATION OF POSITRONIUM. Mankamo, T.; Jauho, P. (Technical Univ. of Helsinki, Otaniemi, Finland). Nucl. Phys.; A158: 487-96(1970).

A method for measuring the momentum correlation in 3γ annihilation of positronium is reported. The energies of two of the annihilation photons were detected in coincidence by NaI scintillators and registered by a two-parameter analyzer. The events corresponding to photopeak absorption of both quanta accumulated in the memory matrix of the analyzer into a ridge around a hyperbola. The background was arithmetically subtracted. The sample used consisted of fine-grained MgO powder, in which the probability for 3γ annihilation amounted to 20 to 22%. The results are compatible with the quantum-electrodynamical cross section. (auth)

16796 MUONIUM. II. OBSERVATION OF THE MUONIUM HYPERFINE-STRUCTURE INTERVAL. Bailey, J. M.; Cleland, W. E.; Hughes, V. W.; Prepost, R.; Ziock, K. (Yale Univ., New Haven). Phys. Rev., A; 3: 871-84(Mar 1971).

A full discussion is given of the microwave-spectroscopy resonance method of measuring the hyperfine-structure interval $\Delta\nu$ of the ground state of muonium, including the theoretical value for $\Delta\nu$, the transition frequencies, and the resonance line shape. A complete description is also given of our experimental method of measuring $\Delta\nu$ at strong magnetic field. The initial experimental results gave $\Delta\nu = 4461.3 \pm 2.0$ MHz, in good agreement with the theoretical value $\Delta\nu = 4463.282 \pm 0.062$ MHz. The first observations of muonium chemistry are described. (auth)

16797 SLOW COLLISIONS IN A THREE-BODY SYSTEM WITH COULOMB INTERACTION. IV. MESIC ATOM PROCESSES IN HYDROGEN. Matveenko, A. V.; Ponomarev, L. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz.; 59: 1593-1607(Nov 1970). (In Russian).

A general method is used for calculating concrete reactions in which mesons participate in a hydrogen isotope mixture. The method consists in expansion of the three-body wave function for Coulomb interaction into solutions of the Schroedinger equation for the two-center problem. Cross sections and the interception coefficients are obtained for transitions of the μ^- meson between hyperfine-structure levels of the mesic atom and also for isotope-exchange reactions. These processes occur in collisions between hydrogen isotope mesic atoms and hydrogen atomic nuclei. The phase function technique is employed in the calculations. The calculation results are compared with earlier calculations and the experimental data. (auth)

Collision Phenomena

Refer also to abstracts 15596, 17150, 17163, and 17597.

16798 (ANL-Trans-872) ^{4}He–^{4}He INTERACTION FROM LOW-ENERGY SCATTERING PROCESSES AND STEP POTENTIAL MODELS. Dohmann, Hans-Dieter (Bonn Univ. (West Germany)). Translated for Argonne National Lab., Ill., from German Thesis. 51p. Dep. NTIS.

Experimental measurements of total cross sections for ^{4}He–^{4}He scattering are described in Part A of this three-part thesis. In part B the usefulness of a step-function model as a molecular interaction potential for calculation of cross sections is demonstrated. Certain rules for the approximation of realistic potentials by the model are given. Part C deals with a modification of the step potential model, which significantly reduces machine calculating time. Part B has been published and an abstract appeared as NSA 23: 14642. Parts A and C are to be published separately. (A.G.W.)

16799 (ORO-3027-18) ABSOLUTE EXPERIMENTAL CROSS SECTIONS FOR THE IONIZATION OF SINGLY CHARGED BARIUM IONS BY ELECTRON IMPACT. Technical Summary Report. Feeney, R. K.; Hooper, J. W. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). 1 Jan 1971. Contract AT(40-1)-3027. 144p. Dep. NTIS.

Absolute cross sections for the single ionization of Ba^+ ions by electron impact were measured as a function of incident electron energy over the electron energy range from below threshold (10.001 eV) to approximately 1000 eV. The measurements were made in an all-metal ultrahigh-vacuum crossed-beam facility in which approximately monoenergetic beams of Ba^+ ions and electrons were caused to intersect at right angles in a well-defined collision volume. Continuous-beam techniques were used for the majority of the measurements, but modulated-beam measurements were used as a check. It was found that the cross section increases from 1.94×10^{-16} to 3.76×10^{-16} cm^2 between 15.5 and 18 eV actual incident electron energy. This rapid rise is interpreted as the onset of autoionization. Some evidence of structure occurring near the peak of the cross-section curve (below 100 eV) was observed, but this was not conclusive. The data are compared with existing experimental and theoretical results. (A.G.W.)

16800 (ORO-3771-3) RECOMBINATION OF POSITIVE IONS WITH ELECTRONS IN GASES. Progress Report, December 19, 1969–December 21, 1970. Franklin, J. L.; Brooks, P. R. (Rice Univ., Houston, Tex. Dept. of Chemistry). 22 Dec 1970. Contract AT(40-1)-3771. 9p. Dep. NTIS.

Preliminary data obtained during the period on dissociative recombination of N_2^+ ions with electrons are reported. The total recombination cross section is estimated to be ~10 Å^2 at an interaction energy of 3 eV, but it falls off dramatically at energies higher than a few eV. A plot of the angular distribution of the N atoms formed shows a symmetric distribution with a minimum in the center. This shape is related to the conservation of angular momentum. Apparatus improvements made during the year are described briefly. (A.G.W.)

16801 EMISSION CROSS SECTIONS OF THE FIRST NEGATIVE BAND SYSTEM OF N_2 PRODUCED BY PROTON IMPACT. De Heer, F. J.; Aarts, J. F. M. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica; 48: 620-8(30 Sep 1970).

Cross sections were measured for the emission of the 0–0 transition of the first negative band system of N_2 when excited by protons in the energy range of 1 to 150 keV. The results are compared with those of other groups and those obtained from electron-impact experiments. For protons the discrepancies in cross sections for the different groups extend to about a factor of 3; for electron impact there is good agreement between data published earlier by the authors and data from three other recent experiments. According to the Bethe or Born theory the excitation cross sections become equal for protons and electrons of equal sufficiently high velocities. When the proton and electron data for the first negative band system are compared, the proton data of other groups, which extend all together between 1 and 800 keV, are normalized on the present proton cross sections. It is then found that the proton- and electron-impact cross sections become almost equal to each other at a velocity of about 10^9 cm/sec, corresponding to 500-keV protons and 270-eV electrons. Both from the fact that this relation is in agreement with theory and that the recent electron experiments are in agreement with each other, it is concluded that a relatively great weight can be put on the reliability of the absolute scale for the 0–0 cross section in the present proton experiment as compared to other groups. (auth)

16802 ELASTIC SCATTERING OF Be^{++} IN He. Giffen, Wallace Cameron. Syracuse, N. Y.; Syracuse Univ. (1970). 94p. University Microfilms Order No. 70-24,079.

Thesis.

An experimental measurement of the interaction potential, V(r), for the Be^{2+}–He system was made over a range of internuclear separation, r, from 0.15 to 1 Å. A Thomas–Fermi–Dirac model theoretical calculation was also made for the range 0.0529 to 0.6350 Å, and the results were compared with the experimental findings. Much of the experimental data follows approximately the Born–Mayer form: $V(r) = 6.0 \times 10^2 \exp(-5.7\ r)$ eV, where r is in Angstrom units. Excellent agreement was found over most of the range of overlap between experimental and theoretical work. The experimental result was derived from analysis of the energy-loss spectra of monoenergetic beams of Be^{2+} ions elastically scattered in He gas at low pressure. Experiments were run at different beam energies between 100 and 800 eV. For each Be^{2+} scattering angle, as seen in the laboratory coordinates, there were two possible impact parameters. This ambiguity was resolved by measuring the energy spectrum of the ions after scattering. There is one to one correspondence between the energy retained by the ion and its cms scattering angle. The detector was a picoammeter connected to a flat ion collector plate normal to the initial beam axis. A fine wire grid in front of the plate established a unipotential plane with respect to which the detector plate could be biased to a beam retarding potential. Thus all ions of energy (associated with the velocity component in the direction of the initial beam) less than some value could be rejected. The grid and plate were large enough to intercept the entire beam of Be^{2+}, scattered or unscattered. By moving the detector along the beam axis, a cross section for scattering outside a given center-of-mass angle could be measured. V(r) was established on a point by point basis by computer integration of the inverted classical orbit equation. The Be^{2+} ions were generated by electron bombardment of Be vapor in a molybdenum oven. A double-focusing magnetic mass spectrometer was employed to select the desired ions. (Diss. Abstr. Int., B)

16803 NUMERICAL INTEGRATION OF CERTAIN DIFFERENTIAL EQUATIONS ENCOUNTERED IN ATOMIC COLLISION THEORY. Lebeda, C. F.; Thorson, W. R. (Univ. of Alberta, Edmonton). Can. J. Phys.; 48: 2937-42(15 Dec 1970).

The problem of accurate numerical integration of the general two-state coupled first-order equations frequently encountered in atomic collision theory is discussed. In particular, it is shown that an asymptotic expansion of the exact solution, valid for times early in the collision where the coupling is still weak, can be obtained by a simple iterative procedure. This expansion can be used to significantly shorten the range of numerical integration, by providing reliable starting values at finite times t_0 where the coupling is not negligible though still weak. It is further shown that spurious small oscillations in the numerical solutions, which are generated when the usual boundary conditions for $t \to -\infty$ are used to provide starting values at finite times t_0, can be removed by using the expansion for starting values at t_0, with resulting improvements by several orders of magnitude in speed and accuracy of the numerical integration. This improvement is illustrated for an example where the coupling interaction has an especially long range. (auth) (Canada)

16804 ANALYTICAL REPRESENTATIONS OF GENERALIZED OSCILLATOR STRENGTHS, EXCITATION CROSS SECTIONS, AND POLARIZATION FRACTIONS. Vriens, L.; Carriere, J. D. (FOM-Instituut voor Atoom- en Molecuufysica, Amsterdam). Physica; 49: 517-31(16 Nov 1970).

Generalized oscillator strengths $f_E(K)$ for transitions in atoms and molecules, and thus differential cross sections for scattering of fast charged particles, can be represented by analytical power-series expansions. One class of expansions is shown to be particularly useful in describing theoretical and experimental data, firstly because integrations yield the excitation cross section σ_E and polarization fraction Π in a simple analytic form. Secondly, the coefficients of the analytical formulas for $f_E(K)$, σ_E, and Π are uniquely determined by atomic or molecular matrix elements. Thirdly, for a number of cases knowledge of a few matrix elements is sufficient to describe $f_E(K)$ accurately for all momentum transfer K that contribute significantly to σ_E and Π. Finally, when applied to experiment, the analytical representations are helpful in extending differential cross sections, which can be measured at the moment only in a limited range of angles, to all smaller and larger angles of interest and thus to obtain total cross sections. An analysis of experimental differential cross sections simultaneously gives information on a few atomic or molecular matrix elements, which for complicated atoms or molecules is not so easily obtained from direct calculations. As an illustration, cross sections and polarization fractions for excitation of He 1^1S, 2^1S, and 2^3S by electrons and protons are calculated from Kim and Inokuti's $f_E(K)$. (auth)

16805 IMPULSE APPROXIMATION IN ATOMIC COLLISION PHYSICS. Vriens, L. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica; 49: 602-12(16 Nov 1970).

Application of the quantum-mechanical impulse approximation in atomic collision physics leads to special problems caused by the long range of the Coulomb interaction between the individual particles. These problems are discussed using the exact T matrix as a starting point for the analysis. The discussion leads to a new variant of the restricted impulse approximation in which multiple scattering terms involving more than one target particle are disregarded. Free–free Coulomb scattering is correctly described by this variant of the impulse approximation and not by the conventional one. This version of the restricted impulse approximation is shown to have a range of validity identical to that of the Born approximation in atomic collision physics, in contrast to the situation encountered in nuclear physics. It is further shown that the plane-wave impulse, plane-wave Born, binary-encounter and classical impulse approximation cross-section formulas can be derived from the quantum-mechanical impulse approximation formulas by making successive approximations. (auth)

16806 PRELIMINARY OBSERVATIONS OF THE ORIENTATION DEPENDENCE OF H_2–Ar SCATTERING BY A NEW TECHNIQUE. Moerkerken, H.; Prior, M.; Reuss, J. (Univ., Nijmegen, Netherlands). Physica; 50: 499-510(31 Dec 1970).

By molecular-beam magnetic-resonance techniques, a state-selected monoenergetic H_2 beam was produced. The beam intensity is attenuated by collisions with Ar molecules in a scattering region. From the attenuation for different H_2 states, the ratio of the total collision cross sections for well-defined rotational quantum numbers (J, m_J) is determined. This ratio contains information on the angular-dependent part of the intermolecular potential. Potential parameters are obtained from a simple potential for the system H_2–Ar. (auth)

16807 REVIEW OF THE THEORETICAL STUDY OF RESONANCES IN ATOMIC COLLISIONS. Chen, J. C. Y. (Univ. of Oslo). Nucl. Instrum. Methods; 90: 237-57(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

The various theoretical methods for the investigation of resonances in atomic collisions are reviewed together with a discussion of the merits and limitations of these methods and their interrelationships. The methods explicitly considered are the Siegert and Kapur–Peierls methods, the Feshbach projection-operator approach, the Faddeev formulation, the pseudostate expansion, and the Harris–Nesbet algebraic expansion. A new method that converges rapidly and has a decisive computational advantage over the conventional coupled-equation method is presented. (auth)

16808 EXPERIMENTAL STUDY OF BEAM–GAS COLLISIONS. I. Andersen, N.; Jensen, K.; Newton, C. S.; Pedersen, K.; Veje, E. (Univ. of Copenhagen). Nucl. Instrum. Methods; 90: 299-304(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

A He gas target was bombarded with H^+, H_2^+, H_3^+, He^+, $^{20}Ne^+$, $^{22}Ne^+$, Ar^+, $^{84}Kr^+$, $^{86}Kr^+$, and Xe^+ ions with energies ranging from 10 to 75 keV. Photons emitted from atoms and ions excited in inelastic collisions or charge-exchange processes were analyzed in the spectral range 200 to 600 nm. Excitation functions were measured for some levels in neutral helium at different gas pressures in the single collision region. The excitation was found to depend on the projectile. When using a specific projectile, no correlation was found between the excitation functions of levels with different principal quantum number. Furthermore, levels with the same principal quantum number, but different azimuthal quantum are excited differently. Corresponding singlet and triplet levels in neutral He were found to have rather similar excitation functions. The maxima and minima are situated at the same energies, but the extrema are much more pronounced in the excitation functions of singlet levels than for the corresponding triplet levels. The 4d ^1D and 4d ^3D levels of He I were excited both with $^{20}Ne^+$ and $^{22}Ne^+$. The slopes of the corresponding excitation functions are found to be almost identical, but the $^{22}Ne^+$-induced radiation is found to be slightly more intense than (up to approximately 10%) or equal to that induced by $^{20}Ne^+$ at the same center-of-mass energy or at the same relative velocity. No measurable differences were found between the $^{84}Kr^+$- and the $^{86}Kr^+$-induced radiation. Many strong lines were emitted from the heavier projectiles. (auth)

16809 EXPERIMENTAL STUDY OF BEAM–GAS COLLISIONS. II. Andersen, N.; Bickel, W. S.; Jensen, K.; Newton, C. S.; Veje,

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E. (Univ. of Copenhagen). Nucl. Instrum. Methods; 90: 305-7 (1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

Collisions of $^{20}Ne^+$ and $^{22}Ne^+$ with a natural composite neon gas target were studied at energies ranging from 10 to 75 keV. Photons emitted from the collision area were analyzed in the spectral range 200 to 600 nm. Lines from Ne I through Ne V were observed. Excitation functions for the 4p $[1\frac{1}{2}]J = 1$ level and the 4p$[1\frac{1}{2}]J = 2$ level in Ne I were measured, and small but distinct differences were found in the slopes of these two excitation functions. Also a similar study of the 4p$[2^1\frac{1}{2}]J = 2$ level and the 4p$[2^1\frac{1}{2}]J = 3$ level showed no constant ratio between the population of level pairs. Differences between the excitation functions of the 4p$[^1\frac{1}{2}]J = 1$ level and the 4p$[1\frac{1}{2}]J = 1$ level were found, indicating that the excitation mechanism may depend on the coupling between the orbital angular momentum of the running electron and the inner quantum number of the core. The excitation function of the 4p$[1\frac{1}{2}]J = 1$ level is found to differ from that of the 4p'$[1\frac{1}{2}]J = 1$ level. The excitation of the 4p$[1\frac{1}{2}]J = 2$ level was studied both using $^{20}Ne^+$ and $^{22}Ne^+$ ions. The $^{22}Ne^+$-induced radiation is found to be slightly more intense than (up to approximately 10%) or equal to that induced by $^{20}Ne^+$ projectiles. The intensities of the transitions from the 4p$[2^1\frac{1}{2}]J = 2$ level to the 3s$[1\frac{1}{2}]^\circ J = 1$ level and the 3s$[1\frac{1}{2}]^\circ J = 2$ level were measured for various projectile energies. The branching ratio was found to be constant within 3% giving a good check of the equipment and measuring procedure. The same satisfyingly good result was obtained for the transitions from the 4p$[1\frac{1}{2}]J = 1$ level to the 3s$[1\frac{1}{2}]^\circ J = 1$ level and the 3s$[1\frac{1}{2}]^\circ J = 2$ level. The results are compared to the theory of molecular orbital level crossings. (auth)

16810 MEASUREMENT OF THE DIFFERENTIAL ELASTIC SCATTERING AND IONIZATION CROSS SECTIONS OF ATOMIC SYSTEMS. Leonas, V. B.; Sermyagin, A. V. (Space Research Inst., Moscow). JETP Lett. (USSR) (Engl. Transl.); 12: 300-2(5 Nov 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 432-6(5 Nov 1970).

The differential elastic scattering and ionization cross sections were measured for the systems He–He, Ne–Ne, Ar–Ar, Kr–Kr, Xe–Xe, and N_2–N_2. From these results interaction potentials were calculated. For the systems He–He and N_2–N_2, a figure shows also the dependence of the probability of electron loss by the fast particle on the impact distance. (A.G.W.)

16811 RECONSTRUCTION OF THE POTENTIAL ACCORDING TO THE DIFFERENTIAL SCATTERING CROSS SECTION AT HIGH ENERGIES. Yakovlev, L. G.; Bashirov, E. M. (Ul'yanov State Teacher's Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 8, 118-23(1970). (In Russian).

A simple formula was used constructing the potential according to the angular distribution of scattered particles at a given energy. The formula can be used in a classical small-angle approximation and in a quasi-classical approximation. Interaction potentials for scattering of ions by atoms of helium, neon, and argon in various combinations at 25, 50, and 100 keV were constructed according to the experimental data. The simplicity of the formula makes it possible to find potentials at greater distances and with less error than those found earlier in the work of Everhart and Lane. (tr-auth)

16812 CORRELATION OF EXCESS ENERGIES OF DISSOCIATIVE ELECTRON ATTACHMENT PROCESSES WITH THE TRANSLATIONAL ENERGIES OF THEIR PRODUCTS. DeCorpo, J. J.; Bafus, D. A.; Franklin, J. L. (Rice Univ., Houston, Tex.). J. Chem. Phys.; 54: 1592-7(15 Feb 1971).

Appearance potentials and translational energies of the products resulting from several dissociative electron capture processes were measured. Excess energies were determined for each process from the measured appearance potentials and known ground-state heats of formation of the products and reactants. As with positive ions, the results were found to agree with the predictions of classical statistical theory. Application of the method is demonstrated in determination of the electron affinity of radicals. (auth)

16813 QUANTUM CALCULATIONS OF COLLINEAR REACTIVE TRIATOMIC SYSTEMS. II. THEORY. Miller, G.; Light, J. C. (Univ. of Chicago). J. Chem. Phys.; 54: 1635-42(15 Feb 1971).

Reaction coordinates are used to develop a general method to calculate quantum mechanically the reactive and nonreactive scattering probabilities for a collinear collision of an atom and a diatomic molecule. This method offers increased flexibility over pervious methods, in that a much wider variety of potential surfaces may be investigated in a much faster scheme of solution. (auth)

16814 INELASTIC NONREACTIVE SCATTERING: THREE ATOMS INTERACTING VIA THREE INTERATOMIC POTENTIAL ENERGIES. Locker, David J. (Vanderbilt Univ., Nashville). J. Chem. Phys.; 54: 1799-1806(15 Feb 1971).

The pioneering calculations of Shuler and Zwanzig imposed many constraints on three-body scattering. Their computations applied to systems interacting collinearly and having an interaction potential energy such that $V = 0$ for intermolecular separations greater than some finite value σ and $V = \infty$ for separations less than or equal to σ. In their studies of atom–diatomic-molecule collisions the incident atom was chosen to interact only with the nearest atom of the diatomic molecule. Cheung and Wilson extended the Shuler and Zwanzig procedure in order to study systems interacting via structured interaction potential energies represented by a series of finite steps. In the latter work, however, the intermolecular interaction was again chosen to be between nearest atoms. In the present work expressions are generated, which represent an incident atom interacting with both atoms of a diatomic molecule. Two interaction potential energies are described. In one case the incident atom acts upon both atoms of the diatomic molecule via a hard-core interaction. For this case, calculations are carried out yielding results generally in agreement with the results of Shuler and Zwanzig. In another case the interactions are each represented by a single step. The present discussion may be extended to examine multistep interactions. (auth)

16815 VARIATION-PERTURBATION TREATMENT OF SCATTERING PROBLEMS. I. POTENTIAL SCATTERING BY A CENTRAL FIELD. Knudson, Stephen K.; Kirtman, Bernard (Univ. of California, Santa Barbara). Phys. Rev., A; 3: 972-8 (Mar 1971).

A variation–perturbation treatment of potential scattering by a central field is presented. The first-order correction $X_l^{(1)}$, to the lth partial wave, which gives the phase shift η_l, through third order, may be determined from a variation principle or as the solution of an inhomogeneous differential equation. Optimization of the initial approximation by means of the Hulthén condition yields a vanishing $\eta_l^{(1)}$ and a bound $X_l^{(1)}$. Encouraging results are obtained in trial calculations on the exponential and Yukawa potentials treated as perturbed spherical holes. The likelihood of extending this approach to include the most powerful techniques of bound-state perturbation theory is anticipated. (auth)

16816 LIFETIMES OF METASTABLE CO AND N_2 MOLECULES. Borst, Walter L.; Zipf, Edward C. (Univ. of Pittsburgh). Phys. Rev., A; 3: 979-89(Mar 1971).

The average lifetime of metastable CO molecules in the $a^3\Pi$ state excited by electron impact at 7.5 eV at room temperature was found to be about 1 msec. Lifetimes of metastable N_2 molecules in the $a^1\Pi_g$ and $E^3\Sigma_g^+$ states were found to be 115 ± 20 and 190 ± 30 μsec, respectively. There was evidence for at least one higher-lying metastable state of CO at about 10 eV having a lifetime of about 0.1 msec. The lifetimes were obtained in a time-of-flight experiment and deduced from the measurements without resorting to analytic expressions of the time-of-flight distribution. The observed time-of-flight distributions were essentially Maxwellian. A diffuse-gas source operated at pressures in the 10^{-4}-torr range was used. Effects due to metastable recoil, uv photons from metastable decay, and metastable wall collisions were carefully examined and found to be negligible under most conditions. Metastable excitation functions were obtained using a low-energy high-resolution electron gun. (auth)

16817 ENERGY AND ANGULAR DISTRIBUTIONS OF ELECTRONS FROM IONIZATION EXCITATION OF HELIUM BY PROTON BOMBARDMENT. Oldham, William J. B. Jr. (Manned Spacecraft Center, Houston, Tex.); Miller, B. Peter. Phys. Rev., A; 3: 942-5(Mar 1971).

Double-differential cross sections (ddcs), relative to ejection energy and angle, were calculated for electrons emitted from helium by proton bombardment for all excited states of the resulting helium ion through the third hydrogenic shell. Comparable calculations were made by using both a 12-term correlated wave function and a product of one-electron wave functions for the initial state of the helium atom. Results are presented for an incident proton energy of 300 keV with various ejection energies and angles. The effect of the correlated wave function was significant for cases involving excitation to the P states. The contribution from these states represented an appreciable percentage of the total ddcs over all states for low and intermediate ejection energies, which was not indicated by the corresponding results from the uncorrelated wave function. (auth)

16818 SIMULTANEOUS IONIZATION AND CHARGE TRANSFER IN FAST-PROTON–HELIUM-ATOM COLLISIONS. Oldham,

William J. B. Jr. (Manned Spacecraft Center, Houston, Tex.). Phys. Rev., A; 3: 951-5(Mar 1971).

The first Born approximation, with the prior interaction, is used to calculate the total cross section for the process $H^+ + He(1s)^2 \rightarrow H(1s) + He^{++} + e^-$. Comparison with existing experimental values is made to the extent that it is possible. Fair agreement is obtained for an impact energy of 50 keV; however, more refined calculations are needed for complete clarification. (auth)

16819 ELASTIC SCATTERING OF POSITRONS FROM HYDROGEN: AN OPTICAL POTENTIAL CALCULATION. Matese, John J.; Fung, Albert C. (Louisiana State Univ., Baton Rouge). Phys. Rev., A; 3: 928-37(Mar 1971).

The optical potential of Bell and Squires is used to formulate the problem of the elastic scattering of positrons from atoms. An application is made to the scattering of S-wave positrons from hydrogen below the threshold for positronium formation. The single-particle states of the electron are chosen to be the hydrogenic solutions, whereas the positron states are obtained by using a single-particle potential that includes the Hartree potential plus a model polarization potential. Various models are investigated and a choice is made that effectively maximizes the calculated phase shifts through second order in the perturbation expansion of the optical potential. Phase shifts thus obtained yield approximately 67 to 80% of the difference between the static Hartree results and the variational results of Schwartz. Higher-order effects are evaluated using the techniques of Kelly. Intermediate states of multipole $l \leq 3$ are included. (auth)

16820 EXCITATION TRANSFER IN COLLISIONS OF HIGHLY EXCITED ALKALI ATOMS. I. CESIUM–NOBLE GASES COLLISIONS. Nikitin, E. E.; Reznikov, A. I. (Inst. of Chemical Physics, Moscow). Chem. Phys. Lett.; 8: 161-4(15 Jan 1971).

The mechanisms of intramultiplet mixing and intermultiplet transitions in a highly excited cesium atom, induced by collisions with inert gas atoms, are discussed. It is argued that the crossing of the excited $^2\Pi$ molecular state by the repulsive $^2\Sigma$ state provides the main channel for nonelastic events. Estimated cross sections are in disagreement with available experimental data. (auth)

16821 ^4He–^4He INTERACTION POTENTIAL BY SCATTERING EXPERIMENTS BETWEEN 0.3 AND 80 meV. Bennewitz, H. G.; Busse, H.; Dohmann, H. D. (Univ., Bonn). Chem. Phys. Lett.; 8: 235-7(15 Jan 1971).

Total cross sections for ^4He–^4He were measured in the energy range 0.3 to 80 MeV. These cross sections provide information on the potential well and the repulsive potential up to 30 MeV. (auth)

16822 COMPUTATION OF CHARGE–TRANSFER PROBABILITY BETWEEN PROTONS AND EXCITED HYDROGEN ATOMS. Malaviya, V. (Queen's Univ., Belfast). Comput. Phys. Commun.; 1: 380-90(Dec 1970).

A computer program is described for simultaneous computation of momentum transfer matrix elements and excitation and charge-transfer probabilities for collisions between protons and hydrogen atoms in the second quantum levels in any of the three molecular states associated with the second quantum level of the H atom. An alternative procedure using direct numerical integration is also discussed and developed. The exchange matrix elements are evaluated by solving a set of coupled differential equations suggested by Cheshire (Proc. Phys. Soc. (London), 92: 862 (1967)). The differential equations relating the transition amplitudes are combined with the differential equations relating the matrix elements and are solved by the Adams–Moulton method. (auth)

16823 ELECTRON SCATTERING BY CLOSED-SHELL DIATOMIC MOLECULES. Sinfailam, A. L. (Univ. of California, San Diego, La Jolla). Comput. Phys. Commun.; 1: 445-52 (Dec 1970).

A general computer code for studying low-energy electron scattering by closed-shell diatomic molecule is presented. It is assumed that the molecule is constrained in its electronic state and does not vibrate or rotate during the collision. The K-matrix elements, the eigenphases, and the elastic cross section are evaluated. The approach is based on a single-center expansion of the molecular and incident electron orbitals about the center of mass of the molecule. The target molecule is represented by the Hartree–Fock molecular wave function. The adiabatic or Born–Oppenheimer approximation, which assumes that the molecular axis does not rotate during the collision, is used to describe the scattering process. The coupled integrodifferential equations are solved using the method of Smith et al. (Phys. Rev., 147: 21(1966)) for electron–atom collisions. (auth)

16824 SEMIQUANTAL THEORY OF HEAVY-PARTICLE EXCITATION, DEEXCITATION, AND IONIZATION BY NEUTRAL ATOMS. I. SLOW AND INTERMEDIATE ENERGY COLLISIONS. Flannery, M. R. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Ann. Phys. (N. Y.); 61: 465-87(Dec 1970).

A theory is presented for the rates of excitation, de-excitation, and ionization arising from the impact of two heavy particles at thermal energies. The rates for the forward and backward transitions are shown to satisfy the principle of detailed balance. Calculations are performed for the $n \rightarrow n+1$, $n+2$, and $n+3$ transitions of atomic hydrogen, initially in quantum level n (10 to 150), induced by collision with hydrogen and helium atoms. Ionization rates from these levels are also given. The excitation rates are compared with those calculated from the approximate theory of Bates and Khare. (auth)

16825 HIGH-ENERGY ATOMIC CHARGE TRANSFERS. Mittleman, Marvin H. (Univ. of California, Berkeley). Phys. Rev., A; 2: 2324-7(Dec 1970).

The usual conclusions concerning the energy dependence of high-energy atomic charge transfer are shown to depend critically upon the short-range singularity of the Coulomb potential. The problem is re-examined for the case of smooth potentials. All the previous conclusions concerning the high-energy dependence of the various approximations are changed. (auth)

16826 THEORY OF NEARLY SYMMETRIC EXCITED-STATE–EXCITED-STATE ELECTRON CAPTURE IN ION–ATOM INELASTIC SCATTERING. Ritchie, Burke (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev. Lett.; 26: 484-6(1 Mar 1971).

Formulas are derived, in the two-state approximation, for the cross sections for ion–atom atom excitation and excited-state ion capture for the case when the excited states are nearly degenerate. Under certain conditions the theory predicts oscillations in the total excitation and capture cross sections resulting from interference between the two degenerate final channels, in qualitative agreement with the measurements of van den Bos on H^+–He excitation collisions and of Hughes et al. on capture into excited states of H. (auth)

16827 ZERO-RANGE-POTENTIAL APPROXIMATION AND INELASTIC SCATTERING OF ELECTRONS BY MOLECULES: $e + H_2$ SCATTERING. Demkov, Yu. N.; Ostrovskii, V. N. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz.; 59: 1765-74(Nov 1970). (In Russian).

The zero-range-potential approximation is extended to the multichannel case. By taking into account phenomenologically splitting of singlet and triplet molecular terms one can calculate in this approximation the cross section for excitation of the triplet state of a molecule by electron impact. The calculations are performed for the $e + H_2$ system. The term energies and widths for the H_2^- molecular ion are calculated. Trajectories of the S-matrix poles on the complex energy surface are investigated as functions of internuclear distance. (auth)

16828 THEORY OF OSCILLATIONS OF THE INELASTIC DIFFERENTIAL CROSS SECTION AT HIGH ENERGIES. Ovchinnikova, M. Ya. (Inst. of Chemical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 59: 1795-1803(Nov 1970). (In Russian).

A theory of oscillations of the inelastic differential cross section near the threshold reduced angle τ_0 is presented for transitions due to pseudointersection of terms. The high-energy approximation and weak coupling between states are assumed in the theory. The latter condition requires that the energy E be greater than the value E_{max} for which the cross section is maximal. Application of the result to an analysis of results Coffey et al. (Phys. Rev., 187: 201 (1969)) on inelastic scattering in the He^+–Ne system indicates good agreement between the theory and experiments. (auth)

16829 VELOCITY DEPENDENCE OF THE TOTAL CROSS SECTION FOR HELIUM–ARGON, NEON–KRYPTON, AND NEON–XENON SCATTERING. Lempert, G. D.; Corrigan, S. J. B.; Wilson, J. F. (University Coll., London). Chem. Phys. Lett.; 8: 67-70(1 Jan 1971).

Velocity dependences of the total collision cross sections for scattering of helium by argon, neon by krypton, and neon by xenon were measured using a time-of-flight method of velocity selection. For neon scattering glory oscillations were observed from which values of ϵr_m (the product of the well depth and the internuclear separation at the minimum) were determined for various Lennard–Jones potentials. Comparison is made with the results from diffusion experiments and differential scattering measurements. (auth)

16830 QUANTUM UNDULATIONS IN THE DIFFERENTIAL CROSS SECTION OF THE ARGON–ARGON SYSTEM AND THEIR RELATIONSHIP TO THE INTERMOLECULAR POTENTIAL.

XUM

Searcy, J.; Wendell, K.; Mueller, C. R.; Sheen, S. (Purdue Univ., Lafayette, Ind.). Chem. Phys. Lett.; 8: 123-5(1 Jan 1971).

The differential collision cross section for the argon–argon system was measured using crossed supersonic beams. As a result of velocity selection the quantum undulations were easily detected. The angular positions of these undulations are strongly related to the bowl area near the potential minimum. (auth)

16831 MEASUREMENTS OF THE CROSS SECTION FOR PENNING IONIZATION OF H BY He 2^3S METASTABLES. Shaw, M. J.; Bolden, R. C.; Hemsworth, R. S.; Twiddy, N. D. (Univ. of York, Eng.). Chem. Phys. Lett.; 8: 148-52(1 Jan 1971).

A flowing afterglow apparatus was used to measure the cross section for Penning ionization of hydrogen atoms by helium 2^3S metastable atoms at thermal energy. The result was found to be $22 \pm 6 \times 10^{-16}$ cm^2 at 300°K, and protons were identified as the major ion product. A novel method employing argon ions was used to obtain hydrogen-atom concentrations. (auth)

Atomic Theory

Refer also to abstract 17328.

16832 (CEA-R-4112) INVARIANCE LIE ALGEBRA AND GROUPS FOR THE NONRELATIVISTIC HYDROGEN ATOM. Decoster, Alain (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Dec 1970. 131p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ. (France).

A general survey of the use of Lie groups and algebras in quantum mechanics is made. An extensive description of the invariance algebra and invariance group for the nonrelativistic hydrogen atom is then given; the development of this group, discovered by Fock, is particularly examined. A bibliography containing 200 references on the invariance groups and algebras of classical and simple quantum mechanical systems is given. (auth) (France)

16833 (UCRL-Trans-1430) STUDY OF TRANSITIONS INVOLVING SEVERAL QUANTA BETWEEN TWO ATOMIC LEVELS. Winter, Jacques. Translated by Walter G. Robinson for Univ. of California, Lawrence Radiation Lab., Berkeley, from Compt. Rend.; 241: 375-7(1955). 5p. Dep. NTIS.

Magnetic dipole transitions induced by an oscillating field, i.e., by the simultaneous action of several photons, are treated theoretically. The results are in agreement with conservation of energy and angular momentum. (A.G.W.)

16834 REVIEW OF THEORETICAL DEVELOPMENTS IN ATOMIC f-VALUES. Weiss, A. W. (National Bureau of Standards, Washington, D. C.). Nucl. Instrum. Methods; 90: 121-31 (1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

Theoretical work on atomic f values is reviewed with particular emphasis on the relation to recent beam–foil measurements. One-electron models currently in use are reviewed and their limitations and range of applicability are discussed. Many-electron, or multiconfiguration, models are also described and their results compared with experiment. Regularities and irregularities along isoelectronic sequences are discussed, and some current problems are presented. (auth)

16835 REVIEW OF RECENT DEVELOPMENTS IN THE STUDY OF DOUBLY (MULTIPLY) EXCITED STATES OF ATOMS. Holoeien, E. (Univ. of Oslo). Nucl. Instrum. Methods; 90: 229-36(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

In recent years the foil-excitation technique has been utilized to give rise to temporarily excited states of ion beams with energies ranging in a suitable region. The population of doubly (multiply) excited states will probably increase considerably with the increase of the ion energy. Obviously, the allowed electric dipole transitions among these states and between them and the lower singly excited states will play an important role in the beam–foil excitation emission spectra. The review is devoted to recent developments within the theoretical study of double excitation (multiple) of atoms; it presents rigorous methods of calculating approximately the energies and corresponding wave functions of these upper levels. The knowledge of these important quantities is necessary if transition probabilities (mean radiative lifetimes) and oscillator strengths have to be computed. (auth)

16836 SOME THEORETICAL INVESTIGATIONS ON SINGLY EXCITED STATES OF TWO-ELECTRON SYSTEMS. Midtdal, J. (Univ. of Oslo); Aashamar, K.; Lyslo, G. Nucl. Instrum. Methods; 90: 259-62(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

The variational perturbation method was applied to the singly excited states $1s2s^{3,1}S$, $1s3s^{3,1}S$, $1s2p^{3,1}P$, and $1s3p^{3,1}P$, carrying the calculations through to 20th-order perturbation functions with 162-term expansions of the Hylleraas type. A different basic set consisting of Hylleraas terms with a hyperbolic factor was also employed for the states $1s2s^3S$ and $1s3s^3S$. This set yields a considerable improvement of the variational convergence of the energy expansions. (auth)

16837 PROGRAM TO GENERATE NUMERICAL ORBITAL FUNCTIONS. Robb, W. D. (Queen's Univ., Belfast). Comput. Phys. Commun.; 1: 457-64(Dec 1970).

The program BASFUN solves the radial Schrödinger equation for any specified central potential and angular momentum, either at a given energy or subject to a given R-matrix boundary condition. In both cases the solution can be made orthogonal to any number of specified functions. The eigenfunctions, which are obtained in numerical form, are required (a) as continuum basis functions in an R-matrix calculation and (b) as Sturmian functions to be used in the calculation of atomic properties such as the van der Waals coefficient. The differential equation is integrated using de Vogelaere's method, over intervals specified by the user. The eigenfunction and eigenvalue are found using Newton's iteration method and orthogonalized to the specified functions using the method of Lagrange undetermined multipliers and Simpson's rule. (auth)

16838 PROGRAM TO CALCULATE THE RADIAL PARTS OF INTERACTION MATRIX ELEMENTS BETWEEN TWO HYDROGENIC WAVE FUNCTIONS AS POWER SERIES. Jamieson, M. J. (Harvard Coll. Observatory, Cambridge, Mass.). Comput. Phys. Commun.; 1: 437-9(Dec 1970).

The study of the collisional excitation of atoms by charged projectiles involves interaction matrix elements of the form $V_{s,s'}(R) = \int \phi_s^*(r)\, 1/|r - R|\, \phi_{s'}(r) dr$, where $\phi_s(r)$ is an orbital describing an atomic electron with position vector r relative to the nucleus, and R is the position vector of the charged projectile. If $\phi_s(r)$ is expanded in hydrogenic wave functions the matrix element is reduced to a sum of expressions such as (1) with the ϕ's replaced by hydrogenic wave functions. An expansion of $1/r - R|$ in spherical harmonics of r and R further reduces the integral to a sum of radial integrals involving hydrogenic wave functions, multiplied by functions of R. The radial integrals are calculated analytically to yield power series. (auth)

16839 CHARACTERISTIC WAVE FUNCTIONS OF A MODEL HAMILTONIAN IN THE THEORY OF THE MANY-ELECTRON ATOM. Gutman, I. I.; Bezpal'ko, R. M. (Odessa Technological Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 8, 124-7(1970). (In Russian).

Characteristic wave functions of a model Hamiltonian were obtained for discrete and continuous spectra. These functions were used for calculating the oscillator strengths of 2s–2p and 2s–3p transitions for lithium. A simple analytical formula for the oscillator strengths of 2s–2p transitions for lithium-like ions was also developed. The calculation error was on the order of 1 to 2%. (tr-auth)

16840 THOMAS–FERMI APPROXIMATION ASSOCIATED WITH AN ARBITRARY FORMULA FOR THE ENERGY LEVELS. Dagens, L. (CEA, Limeil, France). J. Phys. (Paris); 31: 837-46(Oct 1970). (In French).

A generalized Thomas–Fermi density is constructed as a functional approximation of the Hartree density. The Brillouin method is applied to a one-particle state density variationally derived from a given approximate one-dimensional level formula. A one-to-one correspondence exists between the Thomas–Fermi type theory and the related level formula. The WKB formula gives the usual Thomas–Fermi theory. The Kirzhnits and Golden theory is obtained from the Dunham formula (semiconvergent $\hbar^2$ expansion of n(v)). The general formulas for the density, energy, and free energy in the one- and three-dimensional cases are given. More explicit results are obtained when n(v) is restricted to be of the local type. The Kohn and Sham variational principle and the virial theorem are satisfied. The density satisfies a functional integrability condition that generalizes a result of Kirzhnits. The present theory is applied to a density approximation given by Swiatecki. A modified form is established, which is associated with a new level formula and equal to the Swiatecki approximation when the potential satisfies the Laplace equation. (tr-auth) (France)

16841 QUANTUM-ELECTRODYNAMIC TREATMENT OF SPONTANEOUS EMISSION IN THE PRESENCE OF AN APPLIED FIELD. Stroud, C. R. Jr. (Univ. of Rochester, N. Y.). Phys. Rev., A; 3: 1044-52(Mar 1971).

Spontaneous emission by a "two-level atom" interacting with a highly excited field mode is described using quantum electrodynamics without time-dependent perturbation theory. It is found that both the line shape and the Lamb shift are affected by the "applied field." Detailed solutions are presented as a function of the population of the "applied-field mode" and as a function of the detuning. (auth)

16842 THEORY OF RELATIVISTIC MAGNETIC DIPOLE TRANSITIONS: LIFETIME OF THE METASTABLE 2^3S STATE OF THE HELIUM-LIKE IONS. Drake, G. W. F. (Univ. of Windsor, Ont.). Phys. Rev., A; 3: 908-15(Mar 1971).

It has recently been established that the radiative lifetime of the metastable 2^3S state of helium and the helium-like ions is determined by single-photon magnetic dipole (M1) transitions to the ground state, rather than the two-photon process proposed by Breit and Teller. The theory of $nl-n'l$ M1 transitions with $n \neq n'$ is developed in the Pauli approximation and extended to two-electron systems. Terms arising from relativistic energy corrections and finite-wavelength effects are included. The results for hydrogenic systems are shown to be identical to those obtained in the relativistic four-component Dirac formulation. The coefficients in the Z^{-1} perturbation expansion of the $1s2s\ ^3S-1s^{21}S$ M1 transition integral are evaluated through ninth order and used to calculate the M1 emission probabilities from the 2^3S state of the two-electron ions up to Fe xxv. The emission probability for neutral helium is 1.27×10^{-4} sec^{-1}. The results are compared with recent solar coronal observations by Gabriel and Jordan and with a measurement of the 2^3S state lifetime in Ar xvII by Schmieder and Marrus. (auth)

16843 COLLISIONAL EFFECTS ON INDUCED EMISSION AND ABSORPTION TRANSITION PROBABILITIES IN ATOMIC SYSTEMS. Chang, Chung-nan; Koutsoyannis, Sotiris (Stanford Univ., Calif.). Phys. Rev. Lett.; 25: 1399-1403(16 Nov 1970).

The transition probabilities for induced emission and absorption of electromagnetic radiation by an excited atom interacting, in addition to the radiation field, with a system of "perturbers" (in single, binary, and completed encounters) are evaluated. It is found that Dirac's result $W_{ind}/W_{abs} = (\bar{n}_{l\sigma} + 1)/\bar{n}_{l\sigma}$ must be modified by a factor $(1-\alpha n)^2/(1+\alpha n)^2$, where α is related to the interaction potential of the emitter–perturber system as well as to the level structure of the "colliding" atoms, and n is the perturber number density. (auth)

16844 COHERENT EFFECTS IN SPONTANEOUS EMISSION BY UNLIKE ATOMS. Varfolomeev, A. A. Zh. Eksp. Teor. Fiz.; 59: 1702-10(Nov 1970). (In Russian).

The emission spectrum and probability for spontaneous decay are calculated for a system of two two-level atoms, one of which is initially excited. The energy levels of the excited states are assumed to be close, and the distance between the atoms is assumed to be fixed. Electromagnetic interaction between atoms is taken into account. Coherent effects during emission are analyzed. It is shown in particular that, in contrast to the case of like atoms, no metastable states are formed in a system consisting of unlike atoms and all states rapidly decay. (auth)

16845 RESTRICTED LOWER BOUNDS IN THE STATISTICAL THEORY OF ELECTRONIC ENERGIES. Chang, Daniel T.; Golden, Sidney (Brandeis Univ., Waltham, Mass.). Phys. Rev., A; 2: 2370-6(Dec 1970).

The so-called quasi-classical approximations are shown to give, in a certain restricted sense, lower bounds to energy eigenvalues. Variational calculations of the energies of hydrogen-like atoms are carried out as an illustration. (auth)

16846 HIGHER RANDOM-PHASE APPROXIMATION AS AN APPROXIMATION TO THE EQUATIONS OF MOTION. Shibuya, Tai-ichi; McKoy, Vincent (California Inst. of Tech., Pasadena). Phys. Rev., A; 2: 2208-18(Dec 1970).

Starting from the equations of motion expressed as ground-state expectation values, a higher-order random-phase approximation (RPA) for excitation frequencies of low-lying states was derived. The matrix elements in the expectation value are obtained up to terms linear in the ground-state correlation coefficients. The ground state is represented as $e^U|HF\rangle$, where U is a linear combination of two particle-hole operators, and $|HF\rangle$ is the Hartree–Fock ground state. Terms are retained only up to those linear in the correlation coefficients in the equation determining the ground state. This equation and that for the excitation energy are then solved self-consistently. The quasiboson approximation is not made in this procedure, and the overcounting characteristics of this approximation are explicitly discussed. The resulting equations have the same form as those of the RPA, but this higher RPA removes many deficiencies of the RPA. (auth)

16847 EFFECTS OF RADIATION DAMPING IN THE FIELD OF AN INTENSE PLANE WAVE. Arutyunyan, V. M.; Melikyan, A. O. (Inst. of Physics Research, Brevan, USSR). Dokl. Akad. Nauk Arm. SSR; 50: 98-101(1970). (In Russian).

Wigner and Weisskopf first solved the problem of the natural width of an excited atomic level. The excited atomic state is assigned a complex energy whose imaginary part with the minus sign is set equal to one-half of the total probability of emission of a photon per unit time. However this method cannot be used in the presence of an intense electromagnetic wave, and it becomes necessary to turn to quantum electrodynamics. The hamiltonian is written for the system "atom and resonance radiation." After absorption of a photon the system goes to an excited state, which decays with emission of a quantum. The interaction of the atom with the strong field is accurately taken into account, and the re-emission of only a single quantum is considered. Expressions are obtained for the energies of two stationary states of the system "atom and strong radiation field." Scattered quanta appear during transitions between these states. The wave functions of these states are presented. Both stationary states are dampened, and expressions are given for the damping constants. Thus the radiation dampening of the excited atomic state is taken into account. (TTT)

16848 APPROXIMATE SOLUTION OF THE N-ELECTRON PROBLEM IN ONE-DIMENSIONAL CONFIGURATION SPACE. Naray-Szabo, G. (Univ. for Technical Sciences, Budapest). Acta Phys. Acad. Sci. Hung.; 28: 315-22(1970).

By a proper approximation of the interaction term in the Hartree energy expression a simple differential equation can be derived for the one-electron orbitals of a many-electron system. The total wave function and energy of the system are constructed from the successive eigenfunctions and eigenvalues of this equation, which involves the number of electrons as a parameter only. The method shows common features with others (Hartree–Fock without exchange, theory of geminals). The difficulties of the numerical calculations arising with other methods can be vastly reduced and, in spite of the great simplicity for He, Li, and Be, promising accuracy is reached. (auth)

Cosmic Radiation

Refer also to abstracts 15944, 17023, 17032, and 17365.

16849 (AD-710653) STUDY OF COSMIC RADIATIONS AT EXTREMELY HIGH ENERGIES. Final Scientific Report. McCusker, C. B. A. (Cornell-Sydney Univ. Astronomy Centre, Sydney (Australia)). 13 Aug 1970. 16p. (AFOSR-70-2220-TR). NTIS.

The three main purposes of the experiment, listed in the original research proposal, were achieved. These were to determine the slope of the cosmic-ray energy spectrum to 10^{21} eV, to study the arrival directions of very energetic particles, and to study nuclear interactions up to the maximum energy available. (auth) (USGRDR)

16850 (AD-712344) PENUMBRA AND THE CHANGES IN THE EFFECTIVE RIGIDITY OF THE GEOMAGNETIC COSMIC-RAY CUTOFF WITH CHANGES OF THE PRIMARY SPECTRUM IN A QUIESCENT GEOMAGNETIC FIELD. Dorman, L. I.; Gusshina, R. T. Translated from Kosm. Luchi; 8: 158-67(1967). 21p. (AFCRL-70-186; AFCRL-Trans-68). NTIS.

The calculation is presented for the effective rigidity of the geomagnetic cutoff in the presence of the penumbra and the change in this rigidity according to detection of various components at geomagnetic latitudes of 30, 40, and 50°. The calculations are made for satellite altitudes and in the atmosphere as follows: for the neutron component at an altitude of 10 km, at mountain levels, and at sea level; for the hard component at an altitude of 10 km, at sea level, and underground at the depths of 3 and 7 m.w.e. Also found are the expected changes in the effective cutoff rigidity of various instruments for a quiescent geomagnetic field when primary variations occur as a result of chromospheric eruptions or various types of cosmic-ray modulation effects. (auth) (USGRDR)

16851 (AD-713226) COSMIC-RAY MODULATION DURING FORBUSH DECREASES IN 1968–1969. Lockwood, John A.; Singh, Partap (New Hampshire Univ., Durham. Dept. of Physics). Aug 1970. Contract F19628-68-C-0107. 16p. (AFCRL-70-0470). NTIS.

For several Forbush decreases in 1968–69, analyses were made of the counting-rate variations of neutron monitors at different vertical cutoff rigidities, of the different neutron multiplicities recorded by the Mt. Washington and Durham monitors, and of the cosmic-ray telescope on Pioneer 8. Comparisons of the Forbush-decrease changes with those for the 11-year variation indicate that the Forbush decreases are less rigidity-dependent. From these

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data a possible form for the rigidity modulation is obtained. (auth) (USGRDR)

16852 INVESTIGATION OF COSMIC RAYS ON THE ATLANTIC OCEAN. Dorman, L. I. Geofiz. Byull.; No. 21, 51-5 (1969). (In Russian).

A brief review is given of the cosmic-ray expedition organized on November 26, 1967 by the Siberian Inst. of Geomagnetism, Ionospherics, and Radiowave Propagation. The main problems of the expedition, the instruments and devices used, and preliminary results obtained are described. The cosmic-ray studies were carried out by means of three-section neutron monitors, a stabilized system of 35 meson and electron–photon telescopes, balloons, and air sondes. Data, coordinates, and elevations of the air sondes launched along the route from the Baltic Sea to South America are tabulated. (R.V.J.)

16853 APPROXIMATING FUNCTIONS FOR COUPLING COEFFICIENTS OF THE NEUTRON COMPONENT. Sergeev, A. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 413-14(1970).

Translated from Geomagn. Aeron.; 10: 529(1970).

The energy spectrum for the main part of cosmic-ray particles with rigidities $R \lesssim 10^{15}$ eV has been investigated experimentally and is described sufficiently accurately by a power-law dependence (1965). In actual investigations of the variations of cosmic-ray intensity, the functions of the coupling coefficients are determined here from the geomagnetic latitude effect. The coupling coefficient is solved for cosmic neutron component at the epoch of the solar activity minimum (1954) for atmospheric depths h_1 = 1000, 680, and 312 mb. (J.C.W.)

16854 SOME IMPLICATIONS OF MUON INTENSITY MEASUREMENTS AT 4500 m.w.e. Baschiera, Bruno; Bergamasco, Laura; Tabasso, Maria Cristina. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 48: 221-5(Feb 1970).

Experimental results are reported on the exponent of the high-energy muon spectrum in the TeV energy range obtained from muon intensity measurements at 4400 ± 80 m.w.e. in the Mt. Blanc Station. An omnidirectional liquid scintillator scanned by fast photomultipliers in fourfold coincidence arrangement is used to select events of interest. (W.D.M.)

16855 RECORDING OF THE MULTIPLICITY OF THE NEUTRON COMPONENT OF COSMIC RAYS WITH COMPENSATION FOR THE COINCIDENCE EFFECT. Kapustin, I. N. (Polar Geophysical Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 17-20(1970).

Translated from Geomagn. Aeron.; 10: 23-7(1970).

The reported computations show that by slightly complicating the standard multiplicity recorder it is possible to create an instrument where the influence of the coincidence effect on the redistribution of multiplicities during variations in the neutral component of cosmic rays can be nearly completely eliminated. This will permit higher-quality data to be obtained. (auth)

16856 AMPLITUDE OF DIURNAL ANISOTROPY OF COSMIC-RAY INTENSITY. Subramanian, G. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res.; 76: 1093-6(1 Feb 1971).

Amplitude of solar-diurnal variation observed in 1958 to 1964 by cosmic-ray neutron monitors was less (by about 45%) than that expected from corotation of cosmic-ray particles around the Sun. To explain this discrepancy, a cosmic-ray pressure gradient perpendicular to the solar-equatorial plane was suggested and discussed. The amplitude discrepancy is shown to be negligible during periods of high solar activity, thus making the assumption of a transverse gradient unnecessary. The theoretically predicted amplitude of diurnal anisotropy for primary cosmic-ray particles of rigidity is obtained. Deep River trajectory data as outlined by McCracken et al., monitor-response data according to Webber and Quenby, and Mt. Washington neutron-intensity data given by Mathews and Kodama were used. The diurnal variation coefficient calculated agrees within 1% accuracy with the calculations for the period of solar minimum, under corresponding assumptions. A precise calculation of the amplitude of diurnal variation at a given monitor and epoch must use appropriate values for the upper-limiting rigidity of the primary anisotropy and the modulated primary spectrum. (J.C.W.)

16857 CONVECTION-DOMINATED TRANSPORT OF SOLAR COSMIC RAYS. Forman, Miriam A. (State Univ. of New York, Stony Brook). J. Geophys. Res.; 76: 759-67(1 Feb 1971).

The Fokker–Planck equation for the transport of solar cosmic rays in interplanetary space, including the convection and energy-change terms as well as an absorbing boundary at finite distance from the Sun, is solved for the exponential decay phase of solar particle events. The solution is applied to the case of low-energy (≈10 MeV) particles for which convection is important. Convective effects, particularly the relative constancy and energy-independency of the exponential decay time, previously noted in connection with the equilibrium anisotropy, appear explicitly in this solution. (auth)

16858 SIZE OF ANTIMATTER BODIES AND THE PRIMARY VERY HIGH-ENERGY COSMIC-RAY FLUX. Wayland, J. R. (Univ. of Maryland, College Park). Astrophys. Space Sci.; 9: 492-8(Dec 1970).

The consequences of antimatter bodies on the very-high-energy primary cosmic-ray flux are considered. The effects of various models of cosmic-ray origin and properties of astrophysical parameters are discussed. A simple expression for the production of antiprotons in N–N collisions as a function of energy of the incident proton is obtained by utilizing characteristics of particles produced in high-energy collisions. It is assumed that sufficient time will have elapsed for all antibaryons to decay to antiprotons. It is shown that the measurement of antinuclei in the primary cosmic-ray spectrum above 10^{17} eV could help to establish the size of antimatter bodies. (auth)

16859 MEASUREMENTS OF GAMMA-QUANTUM FLUX IN THE PRIMARY COSMIC RADIATION WITH ENERGIES EXCEEDING 50 MeV ABOARD THE SATELLITE KOSMOS-208. Bratolyubova-Tsulukidze, L. S.; Grigorov, N. L.; Kalinkin, L. F.; (and others). Cosmic Res. (USSR) (Engl. Transl.); 8: 124-6 (Jan-Feb 1970).

Translated from Kosm. Issled.; 8: 136-9(Jan-Feb 1970).

For measuring cosmic γ-quantum flux with energies above 50 MeV aboard the satellite "Kosmos-208," a telescope was used consisting of Cherenkov counters with radiators of Plexiglas and lead glass, surrounded by a scintillator for shielding from the background of charged particles. A dependence of the γ quantum counting rate on geographic latitude was observed, probably due mainly to imitations of γ radiation by charged particles. Values are given for the integrated intensities of the γ quanta at high and near-equatorial latitudes. Recent data, which may be interpreted as upper limits of primary γ-ray flux, are: $(1.0 \pm 0.4) \times 10^{-4}$, $(6 \pm 3) \times 10^{-5}$, and $(1.0 \pm 1.0) \times 10^{-5}$ $(cm^2 \cdot sec \cdot sr)^{-1}$ for $E_\gamma \geq 50$, 90, and 146 MeV, respectively. Within the limits of error these results agree with the data obtained aboard the satellite OSO-III. (auth)

16860 MECHANISM FOR COSMIC-RAY MODULATION. Mathews, Titus; Quenby, John; Sear, John (Imperial Coll. of Science and Tech., London). Nature (London); 229: 246-7 (22 Jan 1971).

It is stated that, contrary to common belief, there remains a major puzzle concerning the dynamics of the mechanism responsible for the 11-yr, solar-cycle variation in cosmic-ray intensity. It is shown that the cosmic-ray modulation over a cycle of solar activity cannot be explained by observed variation in solar-wind and interplanetary-magnetic field parameters. These suggestions are made to explain the mechanism: small changes in spectral power to obtain the necessary variation in cosmic-ray intensity, contributions from Forbush decreases; and off-eliptic phenomena. (UK)

16861 LONG-WAVE COSMIC RADIO RADIATION IN CIRCUMLUNAR SPACE. Grigor'eva, V. P.; Slysh, V. I. Cosmic Res. (USSR) (Engl. Transl.); 8: 260-4(Mar-Apr 1970).

Translated from Kosm. Issled.; 8: 284-9(Mar-Apr 1970).

The results are given of measurement of the background due to low-frequency cosmic-radio waves at frequencies of 965 and 200 kHz performed on the artificial lunar satellites Luna-11 and Luna-12. The radiation received by a short dipole antenna at a frequency of 200 kHz can be completely explained and that received at a frequency of 965 kHz can be partially explained in terms of shot noise from interplanetary plasma. The level of radiation in lunar shadow is considerably lower than that in the illuminated region. The low-frequency decrease in the intensity of radio emission is confirmed. No radio emission with a flux higher than 10^{-19} W/m^2 Hz was observed from Jupiter and other sources (apart from the Sun). A strong increase in radio emission is observed in the tail of the Earth's magnetosphere. (auth)

16862 DIFFUSE COSMIC X RAYS OBSERVED FROM BALLOONS. Horstman, H.; Horstman-Morettie, E. (CNR, Bologna). Nature (London), Phys. Sci.; 229: 148-9(1 Feb 1971).

Recent observations during balloon flights (Bleekes and Deerenberg 1970, Rangan et al 1969) and OSO-111 results (Schwartz et al.) gave evidence for the existence of a steep spectrum for diffuse cosmic x rays at energies above between 20 and 30 keV resulting in a change in the spectral index of about one over a short energy range. However, data from rocket flights (Brini et al. 1969) gave a spectral index of 1.95 ± 0.1 throughout the energy range 25 to 200

keV. It is demonstrated that the evaluations of the primary spectrum from balloon-flight data were subject to a systematic error, and some effects of x-ray radiation transfer in the atmosphere were neglected. These errors are discussed. (UK)

16863 COMPARISON OF COSMIC-RAY DIURNAL VARIATIONS OBSERVED AT SEA LEVEL AND MOUNTAIN ALTITUDE AT LOW LATITUDE. Chiba, Toshimi; Kodama, Masahiro Sci. Pap. Inst. Phys. Chem. Res. (Jap.); 63: 83-9(1969).

From Collected Papers of the Institute of Physical and Chemical Research, Tokyo, 42-8(1969).

To discuss which of the anisotropy hypotheses (one-way or multi-way) is more plausible for a better interpretation of the cosmic-ray diurnal variation, the altitude dependence of diurnal variation was investigated, using cosmic-ray neutron data obtained at Mt. Norikura and Itabashi of almost the same threshold rigidity. The phase differences in the first harmonics at both stations were deduced and compared with the calculation results based on the one-way anisotropy model. It is shown that the phase differences observed at mountain altitude and sea level are not always inconsistent with the one-way anisotropy assumption with limited accuracy of measurements, if the possible effect of high winds on the barometric-pressure correction is taken into account. (auth)

16864 REPORT OF COSMIC-RAY NEUTRON OBSERVATION IN THE 8th JAPANESE ANTARCTIC RESEARCH EXPEDITION 1967–1968. Ishida, Yoshio (Fukushima Univ., Japan); Kodama, Masahiro. Nankyoku Shiryo; No. 35, 1-21(1969). (In Japanese).

From Collected Papers of the Institute of Physical and Chemical Research, Tokyo, 1-21(1969).

At Syowa Station, Antarctica, the cosmic-ray neutron observation was made with the IGY-type neutron monitor from March 1960 to December 1961. A new type of cosmic-ray meter, IQSY-type neutron monitor, was installed. The recording system for observation comprises the so-called multiplicity meter, by which the counting rates are divided into six channels, multiplicity = 1 to more than 6, according to the neutron multiplicity detected within the gating time of 1 msec. The counting rates are automatically printed and punched on a tape every ten minutes. The cosmic-ray observation room was specially designed so as to avoid influence of snowdrift and the room temperature was 20 ± 1°C. Details of the cosmic-ray neutron observation in 1967–1968 are described, and some results deduced from data analyses are given. The atmospheric effect, the diurnal variation, and the Forbush decrease were investigated in connection with the neutron multiplicity, particularly with regard to the remarkable Forbush event in May 1967. (TSS) (auth)

Direct Energy Conversion

16865 (AD-713672) TEMPERATURE MEASUREMENTS IN FDL 50-MEGAWATT ELECTROGASDYNAMIC FACILITY. Final Report. Olsen, H. N.; Kelly, F. L.; Bedjai, G. (Plasma Sciences Labs., Inc., Van Nuys, Calif.). Oct 1970. Contract F40600-69-C-0007. 26p. (AEDC-TR-70-238). NTIS.

Temperatures in the free stream of a 50-MW electrogasdynamic test facility were determined from experimentally measured radial intensity profiles of the electron continuum. Static plasma pressures were 10 and 20 atm in flowing air and measured temperatures ranged from 3800 to 5400 K. A spectral probe defined by the optical path of a $\frac{1}{4}$-meter grating spectrograph and focusing lens was traversed across the shock cone of the plasma before and after insertion of test samples. Calibration curves for the detector were used for relating the measured intensity to temperature. The results indicate that the nitric oxide concentration in the plasma is lower than the equilibrium value expected at these temperatures. (auth) (USGRDR)

16866 ELECTROMAGNETIC ENERGY CONVERSION DEVICES AND SYSTEMS. Nasar, S. A. Prentice-Hall Electrical Engineering Series. Englewood Cliffs, N. J.; Prentice-Hall, Inc. (1970). 405p. $15.50.

The book introduces the principles and techniques of study of electromagnetic energy conversion devices and systems; it was developed, keeping in mind the current trends in electromechanical energy conversion. Use of computers, analog and digital, and the application of electromagnetic field theory are emphasized. Computer programs, in FORTRAN, are given for a number of examples, leading to numerical end results. (auth)

16867 SELECTION OF THE TYPE AND PARAMETERS FOR LARGE ELECTRIC POWER PLANTS WITH MHD GENERATORS. Rossievskii, G. I.; Koryagina, G. M. Izv. Akad. Nauk SSSR, Energ. Transp.; No. 6, 105-10(Nov-Dec 1970). (In Russian).

It is suggested that air enrichment with oxygen may be used as one method for reducing the temperature of the oxidant in power plants using MHD generators. The thermal scheme of the power plant was analyzed for determining the efficient use of oxygen enrichment, considering the oxygen concentration in the oxidant and the temperature of oxidant heating as a function of the parameters behind the channel of the MHD generator. Power plant parameters are suggested with preheating temperature of the enriched oxidant 850°C and 49.3% efficiency. (tr-auth)

16868 LENGTHWISE EDGE EFFECT IN THE SECONDARY SYSTEM OF THE LINEAR MAGNETOHYDRODYNAMIC INDUCTION MACHINES. Vol'dek, A. I. Tr. Tallin. Politekh. Inst., Ser. A; No. 266, 15-42(1968). (In Russian).

The flat machine with endless cores and with the winding on 2 p poles laid on the limited part of the core is considered. A variety of cases with the compensation elements of windings, i.e., with the ideal short-circuited turns around the active zone of the core and with the insulating sheets in the channel behind the active zone, are considered. It is assumed that the currents of the primary winding, compensation elements, and the short-circuited turn are spread uniformly along the thickness of the gap. Therefore, the mathematical expressions are simplified and are expressed by the final form, but not in the form of the series. The expressions for vector potential, electromagnetic power, electromagnetic forces, mechanical power, and losses are given. The conditions when the edge effects are entirely absent are identified. (auth)

16869 ANALYSIS OF A SINGLE-PHASE GENERATOR-TRANSFORMER CASCADE EQUIVALENT TO A SYNCHRONOUS MGD-GENERATOR. Ciechanowicz, Piotr. Pr. Inst. Masz. Przeply.; No. 50, 129-44(1970). (In Polish).

A cascade composed of a single-phase generator and transformer substituting for a synchronous MGD generator was analyzed. The compensation for the generator armature reaction in the first component of the cascade is discussed, and guidelines for calculating the parameters of the substitutional transformer as the second component of the cascade are defined. Finally, a program for the preliminary designing of a MGD generator, based upon the said substitutional system, is discussed. Fundamental formulas linking the design parameters with the electromagnetic ones of the MGD generator are specified. A novel layout of the generator main core in the form of a symmetric magnetic circuit is proposed. (auth)

Fluid Physics

16870 MAGNETOHYDRODYNAMIC ROTATION OF A CONDUCTING LIQUID IN AN ANNULUS. Hanson, John Parker. Philadelphia; Univ. of Pennsylvania (1970). 110p. University Microfilms Order No. 70-25,657.

Thesis.

The problem of a liquid conductor confined between two concentric, perfectly conducting, cylindrical electrodes is considered. The liquid is caused to rotate by the Lorentz force resulting from the simultaneous application of an axial magnetic induction field and an axial current. Steady-state conditions prevail when the Lorentz force is balanced by viscous forces acting on the walls of the container. The exact relations describing the steady-state flow and induced fields are derived and then simplified. It is shown that the radial and axial components of flow must appear in the simplified relations. Asymptotic techniques are used to simplify the exact equations for conditions which are of experimental interest. In simplifying these equations, nine asymptotic regions are identified: a main (inviscid) region filling most of the volume of the device, four thin viscous boundary layers on the walls of the device, and four transition regions in the corners of the device. Viscous effects are shown to be unimportant in the main region, but the secondary flows are shown to be crucial. Although no solutions have been obtained, similarity laws are easily deduced and correlations are suggested. Experimental evidence is presented which tends to support these correlations. Conditions under which the circumferential components of the velocity and the magnetic induction can be de-coupled from the secondary velocity are described. Under these conditions the secondary velocity must be included in order to compute the pressure intensity. It is shown that these conditions can only be realized for extremely small electrical currents and fluid velocities. (Diss. Abstr. Int., B)

16871 INFLUENCE OF MAGNETIC FIELD ON HEAT EXCHANGE OF AN ABNORMALLY VISCOUS FLUID. Kartsev, V. A.; Sviklis, B. B. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 5, 74-9(1970). (In Russian).

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Plane laminar MHD flow of a conducting fluid subjected to gradual rheological law in a channel with nonconducting walls was studied. A solution of an energy equation for a monotonous, completely hydrodynamically and thermally developed flow of an abnormally viscous, homogenous, incompressible liquid was obtained. The dependence of the number Nu on the generalized number M for the MHD flow of a non-Newton power fluid at different values of both the rheological parameter n and heat load k on channel walls was analyzed both with and without accounting for the abnormally viscous and Joule dissipation. (auth)

16872 HEAT AND MASS TRANSFER IN MHD BOUNDARY LAYER UNDER THE INSUFFLATION AND EXHAUSTION. Blum, E. Ya. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 5, 53-64(1970). (In Russian).

Heat and mass transfer in a flat incompressible MHD boundary layer on a porous plate was studied. The distribution of either insufflation or transfer rate along the plate is set according to the law $v_0\delta/\nu$ = const. Integral impulse and energy equations are solved approximately using the Karmann–Pol'gausen method with the fourth-power polynoms. The applicability of the method used is estimated, comparing the calculated data with the known precise solutions and the asymptotic solutions for the large exhaustion parameters. It is shown that, in the flows with insufflation, the influence of the transverse magnetic field on characteristics of friction as well as on heat and mass transfer is expressed considerably better than in common MHD flow. It is established that, in the case of exhaustion, the influence of the field decreases. (auth)

16873 RECONNEXION OF MAGNETIC FIELD LINES IN CONDUCTING FLUIDS. Yeh, Tyan; Axford, W. Ian (Univ. of California, San Diego, La Jolla). J. Plasma Phys.; 4: 207-29 (May 1970).

The reconnection of magnetic field lines is described for a special case of steady, incompressible hydromagnetic flow in two dimensions. A similarity solution is obtained that corresponds to the flow of a perfectly conducting, inviscid fluid such that magnetic field lines are carried from two sides toward, then on the other two sides away from, the center of an X configuration. (auth) (UK)

16874 HYDROMAGNETIC STRUCTURE OF A CURRENT SHEET. Cassen, Patrick (Ames Research Center, Moffett Field, Calif.). J. Plasma Phys.; 4: 301-16(May 1970).

The structure of the hydromagnetic boundary layer formed by the mixing of two streams of fluid containing oppositely directed magnetic fields is investigated. The flow and magnetic field are aligned at infinity. The fluid was considered to be compressible, viscous, and electrically and thermally conducting. Solutions are presented for the density, velocity, and magnetic field variations through the boundary layer. (auth) (UK)

16875 FLOW OF A RAREFIED PLASMA AROUND A BODY. Bogashchenko, I. A.;Gurevich, A. V.;Salimov, R. A.; Eidel'man, Yu. I. (Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 59: 1540-55(Nov 1970). (In Russian).

The structure of the disturbed zone in the vicinity of a disc around which a rarefied plasma is flowing is studied in detail by the Langmuir-probe technique. The plasma is produced in a Q device. The density, velocity, and temperature in the plasma flow, surface potential, and position of the body are varied. The measurements and their comparison with theory indicate the presence of ion acceleration in a self-consistent electric field produced in the plasma. Simultaneously, the longitudinal ion temperature considerably drops. The body trace has an oscillatory structure. An investigation of oscillation damping shows that the longitudinal and transverse ion temperatures gradually level out as a result of collisions. It is shown that the change of sign of the body potential relative to that of the plasma does not appreciably affect the structure of the disturbed zone behind the body. A change of sign of the potential of another body located in the disturbed zone of the first body strongly affects the structure of the zone in the region between the bodies. The results of the measurements are in accordance with theory. (auth)

Geophysics (Upper Atmosphere)

Refer also to abstracts 16738, 16862, 16873, 17221, and 17243.

16876 (AD-710742) INSTABILITIES OBSERVED IN LOWER E LAYER ALKALI-PLASMA-CLOUD RELEASES AND THEIR IMPLICATIONS REGARDING SPORADIC E. Davis, John R. (Naval Research Lab., Washington, D. C.). 28 Jul 1970. 111p. (NRL-7105). NTIS.

A study of gun- and rocket-emplaced alkali plasma clouds in the 85- to 105-km altitude region of the ionosphere is described. The object of the investigation is to study the small-scale (tens-of-meters), short-term (fractions-of-seconds) irregular motion of the magnetofluid in the lower E layer. Motions on this spatial and temporal scale are known to be responsible for radiofrequency scattering at E-layer heights, and it has been suspected that they are important in the appearance and evolution of the sporadic-E layer. The resolution necessary to discern motions on the scale indicated was afforded by decameter- and meter-wavelength coherent pulse-doppler radar. A survey of possible instability mechanisms that can explain the spatial and temporal scales of the irregular motion observed in Phase III of plasma-cloud evolution leads to the conclusion that dissipative instability involving crossed electric and magnetic fields in the presence of a properly oriented plasma-density gradient is the most likely candidate. It is found that the observed tens-of-meters instability wavelengths and tenths-of-seconds growth times are predicted by this mechanism, and curves of these parameters are presented for various altitudes, electrostatic field intensities, and wavelengths. (auth) (USGRDR)

16877 (AD-710768) ON THE RELATIONSHIP OF THE PLASMA SHEET, RING CURRENT, TRAPPING BOUNDARY: AND PLASMAPAUSE NEAR THE MAGNETIC EQUATOR AND LOCAL MIDNIGHT. Frank, L. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jun 1970. Contracts N00014-68-A-0196-0003; NAS5-2054. 46p. NTIS.

Observations of the complex structure of the near-Earth termination of the plasma sheet in the pre- and post-midnight sectors of the magnetosphere near the magnetic equator were obtained with a sensitive electrostatic analyzer array flown on the Earth satellite OGO 3 during June through July 1966. Principal observational results are discussed. (USGRDR)

16878 (AD-710769) ENERGY SPECTRUMS FOR PROTON (200 eV $\lesssim$ E $\lesssim$ 1 MeV) INTENSITIES IN THE OUTER RADIATION ZONE. Pizzella, G.; Frank, L. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jul 1970. Contracts N00014-68-A-0196-003; NAS5-2054. 20p. NTIS.

The directional, differential spectrums of proton intensities mirroring near the magnetic equator in the outer radiation zone are obtained for the energy range 200 eV $\lesssim$ E $\lesssim$ 1 MeV with measurements from the spacecrafts OGO 3, Explorers 12 and 14 and Mariner 4. Several implications of these observational results with respect to current magnetospheric models of diffusion and acceleration mechanisms are discussed. (auth) (USGRDR)

16879 (AD-710800) INVESTIGATION OF HORIZONTAL ION DENSITY GRADIENTS IN THE ATMOSPHERE. Final Report, July 15, 1965–May 29, 1970. Sharp, Gerald W.; Sharp, Richard D.; Johnson, Richard G. (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.). May 1970. Contract Nonr-4969(00). 68p. (LMSC-L-39-70-1). NTIS.

A satellite measurement program to investigate the characteristics and causes of horizontal ion-density gradients in the F-region ionosphere is described. The report covers the development of the payload, the satellite orbital operations, and the preliminary data-analysis phase of the program. The satellite payload was successfully launched on the OV1-18 satellite on March 18, 1969 into a polar orbit with apogee at 590 km and perigee at 469 km. The payload performed generally well throughout the first year's operation, although the satellite failed to achieve the desired Earth-centered orientation. A large body of generally high-quality flight data was acquired that promises to yield significant results on the systematic relationships between the ionospheric structure at the satellite altitude and the input energy sources in the form of energetic particle fluxes. Electron-density and temperature measurements with a Langmuir probe were acquired during the first 225 orbits. The preliminary data analysis shows that ionospheric structure is observed and is significant. Computer programs have been used to perform detailed surveys of the particle fluxes for some early orbits. (auth) (USGRDR)

16880 (AD-711365) FIRST-ORDER PREDICTION MODEL OF TOTAL-ELECTRON-CONTENT GROUP PATH DELAY FOR A MIDLATITUDE IONOSPHERE. Air Force Surveys in Geophysics. Klobuchar, John A.; Allen, Richard S. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 8 Jul 1970. 27p. (AFCRL-70-403; AFCRL-AFSIG-222). NTIS.

An ionospheric total-electron-content prediction model was developed at AFCRL for use in correcting range errors encountered by operational UHF radar systems and the proposed L-band 621B multisatellite position-fixing system. These system range errors are due to the excess-time delay encountered as

the radio wave passes through the Earth's ionosphere, and are proportional to the total number of electrons through which the wave must pass on its way from transmitter to target. In response to a request by SAMSO, a model was developed by AFCRL in which the range error due to the ionosphere can be expressed in terms of the critical frequency of the ionosphere, f_0F_2, a parameter that is currently predicted on a worldwide basis for military users by the Air Weather Service. Using total-electron-content data taken at the AFCRL Sagamore Hill Radio Observatory, an analytic model was constructed. It was tested against other data available from member countries in the Joint Satellite Studies Group, an informal affiliation of scientific groups from several countries that is studying ionospheric parameters using satellite beacon signals. Tests of the model using actual f_0F_2 data show a smaller rms error than the use of monthly median values of the original total-electron-content data would have given. (auth) (USGRDR)

16881 (AD-711394) ACCURATE SECOND-ORDER THEORY FOR TRANSIONOSPHERIC PROPAGATION. Reinisch, Bodo W. (Lowell Technological Inst., Mass. Research Foundation). Dec 1969. Contract F19628-68-C-0259. 174p. (LTIRF-308/IP; AFCRL-70-68). NTIS.

Measurements on high-frequency signals from beacon satellites are used for calculation of the ionospheric-columnar electron content. An array of antennae and a complex receiving system were necessary to measure dispersive Doppler shift, Faraday rotation, and ionospheric refraction simultaneously on three frequencies: 20, 40, and 41 MHz. Main emphasis is given to the development of a new second-order theory for phase-path difference which considers, besides refraction and geomagnetic-field effects, also the sphericity of the ionosphere. The correction terms caused by the sphericity dominate the second-order terms caused by the ray refraction. For several satellite passes the significance of the second-order effects is demonstrated. (auth) (USGRDR)

16882 (AD-711524) SOLAR-CYCLE DEPENDENCE OF THE IONOSPHERIC ELECTRON CONTENT. Daniels, Fred B. (Army Electronics Command, Fort Monmouth, N. J.). May 1970. 39p. (ECOM-3292). NTIS.

The Faraday rotation of lunar radio echoes was used to measure the ionospheric electron content from the trough to the peak of the current solar cycle. The smoothed average of the daily maximum values is found to be related through a linear-regression equation to the smoothed sunspot number. Since the latter is predictable, the former can also be predicted. Diurnal and seasonal changes relative to this smoothed average can be estimated from the plotted diurnal curve corresponding to the sunspot number of interest. (auth) (USGRDR)

16883 (AD-711573) ATLAS OF LUNAR DATA AND SATELLITE DATA. PLOTS OF IONOSPHERIC FARADAY ROTATION AND ELECTRON CONTENT VERSUS TIME. VOLUME VI. 1967. Final Special Report. Webb, Harold D. (Illinois Univ., Urbana. Electrical Engineering Research Lab.). 1967. Contract DA-36-039-AMC-03703(E). 383p. NTIS.

Volume VI of the Atlas contains plots of Faraday-rotation angle and plots of electron content. Both are plotted versus central standard time (CST) and local time of the average sub-ionospheric point (LTASP) for the observations made during the period January 1, 1967 through September 30, 1967. (auth) (USGRDR)

16884 (AD-711813) DIRECT, DURABLE CAPTURE OF 1- TO 8-MeV SOLAR ALPHA PARTICLES INTO GEOMAGNETICALLY TRAPPED ORBITS. Van Allen, James A.; Randall, Bruce A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jul 1970. Contracts N00014-68-A-0196-0003; NAS1-8141. 15p. NTIS.

A study was made of the hypothesis that the major rapid increases in the intensity of durably trapped 1- to 8-MeV alpha particles are caused by the direct capture of solar particles from the interplanetary medium. Such capture is possible only during geomagnetic storms of appropriate, but as yet undefined, characteristics. (auth) (USGRDR)

16885 (AD-712726) X-RAY AND PARTICLE RADIATION AT HIGH ALTITUDES IN THE AURORAL ZONE. Final Progress Report, July 1, 1969-June 30, 1970. Trefall, Harald (Bergen Univ. (Norway). Dept. of Physics). Sep 1970. Contract AF61(052)-869. 6p. (AFOSR-70-2402-TR). NTIS.

A summary of field work, analysis of data, and other related activities are given for the period July 1969 to June 1970. Fifteen balloons with payloads for the recording of auroral-zone x-ray events were launched from Andenes during July and August 1969. The recordings are being analyzed. The plans for 1970-71 are outlined. (auth) (USGRDR)

16886 (AD-713000) RADAR SCATTERING FROM TURBULENT PLASMAS. Final Report. Abney, Robert; Bowles, Kenneth L. (California Univ., San Diego. Dept. of Applied Physics and Information Science). 1969. Contract DAHC04-67-C-0060. 57p. (AROD-7404:1-P). NTIS.

Radio star scintillation observations carried out at the Jicamarca Radio Observatory during the period February-August, 1968 are reported. After an initial period of equipment setup and testing, observations were conducted whenever time was available at the Jicamarca facility. Electron density irregularities embedded in the electrojet were observed by Balsley (1967) to exhibit certain turbulence-like characteristics. Those observations were based on radar backscatter measurements. The radar measurements indicated the presence of large-scale (~1 km) irregularities with which the backscattering irregularities were associated. Accordingly, it was thought that forward-scatter observations such as radio star scintillation measurements would allow a useful and independent observation of the "turbulent" irregularities. (auth) (USGRDR)

16887 (AD-713691) BASIC PROCESSES AND CROSS SECTIONS IN PROTON AURORAS. Report for May 15-August 15, 1970. McNeal, Robert J.; Birely, John H. (Aerospace Corp., El Segundo, Calif.). 8 Sep 1970. Contract F04701-70-C-0059. 18p. (TR-59(9260-01)-10; SAMSO-TR-70-372). NTIS.

A proton aurora is a weak, diffuse emission readily identified by Doppler-shifted hydrogen lines in its spectrum. It is caused by precipitation of protons with a broad energy distribution that peaks near 1 keV. For theoretical analysis of this aurora, cross sections for ionization and excitation of atmospheric constituents by energetic protons and hydrogen atoms are needed over a wide energy range. Recent measurements of these cross sections are reviewed, and preliminary results for excitation of some of the hydrogen emissions are reported. (auth) (USGRDR)

16888 (JPRS-52234) RELATIVISTIC THEORY OF ORIGIN OF THE EARTH'S MAGNETIC FIELD AND THE CONTRACTION MECHANISM. Aslanyan, A. T. Translated from Izv. Akad. Nauk Arm. SSR, Geol. Geogr. Nauki; 13: No. 6, 55-7(1960). 4p. Dep. NTIS.

This communication presents further development of the concept of spontaneous magnetization of the Earth as set forth in an earlier note by the author (Izv. Akad. Nauk Arm. SSR, Ser. Geol. Geogr., 13: No. 1, (1960)) and entitled "The Earth's Magnetic Field as a Relativistic Effect." (auth)

16889 (N-70-36900) STUDY OF THE DYNAMICS AND IONIZATION OF THE UPPER ATMOSPHERE. Final Report. Smith, L. G.; Bedinger, J.; Constantinides, E. (GCA Corp., Bedford, Mass. GCA Technology Div.). Jul 1970. Contract NASw-1881. 52p. (NASA-CR-112349; GCA-TR-70-3-N). NTIS.

Simultaneous measurements of electron-density profiles obtained with rocket-borne Langmuir probes and wind profiles determined from vapor trails released from the same rocket were made at Wallops Island, Va. during the early morning of Feb. 22, 1968. In addition to the usual features of the nighttime E region, a layer of enhanced electron density was observed to descend from 140 to 110 km during the six-hour period between midnight and sunrise. It is concluded that this layer probably occurs regularly in the E region at night, but is often blanketed by underlying layers and thus not recorded on ionograms. A simple theory of redistribution of ionization by horizontal winds accurately describes the motion of this layer. Application of the theory allowed determination of consistent values of the effective recombination coefficient and also revealed that the effects of electric fields were small during the observing period. In the lower E region the winds produced relatively small ion-drift velocities, and layers of enhanced electron density were observed to persist for several hours. (auth) (STAR)

16890 (N-70-37390) MAGNETOPAUSE STRUCTURE DURING THE MAGNETIC STORM OF SEPTEMBER 24, 1961. Sonnerup, Bengt U. O. (Dartmouth Coll., Hanover, N. H. Thayer School of Engineering. New Hampshire Univ., Durham). Jul 1970. 41p. (NASA-CR-112787). NTIS.

An account is given of the Explorer 12 magnetic field observations of the magnetopause current layer on the inbound pass, which occurred during the main phase of a moderately strong magnetic storm. The accuracy of the Explorer 12 data reported was increased by use of an improved-filtering procedure. Five magnetopause penetrations were observed in a time period of about 20 minutes; for each of these the data were used to calculate the vector normal to the current layer, the magnetic-field component along the vector, and the polarization of the current layer. Normal

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magnetic field components significantly different from zero were obtained, and it is suggested that the observations during this pass in general are consistent with the so-called open-magnetosphere model. (auth) (STAR)

16891 (N-70-37510) METHOD FOR SIMULATING VAN ALLEN BELT PROTON ENERGY SPECTRA. Watts, John W. Jr.; Burrell, Martin O. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). 16 Sep 1969. 18p. (NASA-TM-X-53921; MSFC-IN-SSL-68-18). NTIS.

A proton source with the expected spectral characteristics must be produced to study radiation effects caused by geomagnetically trapped high-energy protons. A method for generating such spectra using a spinning wheel of varying thickness is described. Resulting wheel shapes for two typical proton spectra are shown. (auth) (STAR)

16892 (N-70-39303) ALTITUDE VARIATION OF ION COMPOSITION IN THE MIDLATITUDE TROUGH REGION: EVIDENCE FOR UPWARD PLASMA FLOW. Brinton, Henry C.; Grebowsky, Joseph M.; Mayr, Hans G. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Aug 1970. 25p. (NASA-TM-X-65328; X-621-70-311). NTIS.

Midday ion-composition measurements made by the Explorer 32 ion mass spectrometer in the mid-latitude trough region (L = 5.0 to 10.5) are compared with measurements made within the plasmasphere (L = 1.8 to 2.2). In the trough, the H^+ and He^+ ion concentrations are observed to decrease with altitude between 600 and 2500 km, a region in which O^+ is the major ion. Within the plasmasphere, however, the concentrations of the light ions, when minor, increase with altitude. Model calculations indicate that the behavior of the plasmasphere profiles is consistent with a state of stationary diffusive equilibrium, whereas a dynamic plasma state is required to account for the trough distributions. Upward-directed H^+ fluxes having near-sonic speeds above 2000 km are required to reproduce the measured trough variations. This trough wind, consisting of a rapid upward flow of H^+, can be interpreted as evidence for the convection of the supersonic polar wind onto closed-trough field lines. (auth) (STAR)

16893 (N-70-40998) LONG-TERM VARIATIONS IN HIGH-ENERGY GEOMAGNETICALLY TRAPPED PARTICLES. De Forest, Sherman Edward (California Univ., San Diego. Dept. of Physics). Jul 1970. 64p. (NASA-CR-113812; UCSD-SP-70-2). NTIS. Thesis.

The omnidirectional flux of geomagnetically trapped protons of 40 to 110 MeV was measured by identical detectors on-board three spacecraft (Injun 3, Explorer 15, and Explorer 26) from 1963 to 1966. These data are shown to be consistent with a model of protons diffusing by violation of the third adiabatic invariant. (auth) (STAR)

16894 DUAL SATELLITE OBSERVATIONS OF EARTH'S BOW SHOCK. II. FIELD-ALIGNED UPSTREAM WAVES. Greenstadt, E. W. (TRW Systems Group, Redondo Beach, Calif.); Green, I. M.; Inouye, G. T.; (and others). Cosmic Electrodyn.; 1: 279-96(Dec 1970).

A near conjunction of Vela 3A and Explorer 33 occurred in and around the Earth's bow shock on July 12-13, 1966. During conjunction, many examples of upstream waves of a few gammas amplitude and tens of seconds period were observed, some separately, some simultaneously by both satellites. One particular wave event started first at Vela, close to the shock, then later at Explorer, further out. The $B-V_{sw}$ plane formed by interplanetary field B and solar wind velocity V_{sw} is introduced and applied to analyze the changing relationship of vehicles, field, and shock during the progress of the event. During the event, and apparently through the remainder of the data interval as well, the wave phenomenon moved upwind along B at an effective net velocity of around 1.6 V_{sw}. Left-hand polarizations of the waves suggest they were whistler-mode waves generated by shock-reflected protons, then convected downstream by the solar wind. Observed 50-sec periods can be accounted for by doppler shortening of the wave periods. (auth)

16895 DUAL SATELLITE OBSERVATIONS OF EARTH'S BOW SHOCK. III. FIELD-DETERMINED SHOCK STRUCTURE. Greenstadt, E. W. (TRW Systems Group, Redondo Beach, Calif.); Green, I. M.; Inouye, G. T.; (and others). Cosmic Electrodyn.; 1: 316-27(Dec 1970).

The results of two companion studies of the structure of the Earth's shock contain the implication that the ordinary jump shock is transformed into a pulsation shock with upstream magnetic waves wherever the interplanetary field is not largely tangent to the surface. The waves and the outer envelope of the pulsation shock appear to expand in the direction of the interplanetary field. These effects suggest an overall model of the shock exhibiting both abrupt and pulsation character, with the structure at any point dictated by local orientation of the interplanetary field to the contour of the shock in the plane formed by the field and the solar wind velocity. The model depicts the shock "surface," or outer envelope, as having a wavy, bulging, usually asymmetric, and time-dependent profile. The average asymmetry of the envelope should be more pronounced during solar quiet than active times. (auth)

16896 AMPLIFICATION OF ELECTROSTATIC WAVES IN THE NEUTRAL SHEET. Tendys, J. (Imperial Coll. of Science and Tech., London). Cosmic Electrodyn.; 1: 328-47(Dec 1970).

The orbits obtained by Speiser for particles entering the neutral sheet and being accelerated are used to find the current due to a wave perturbation. If the system can be supposed to be at marginal stability, and this will be the case if the waves radiate out the sides of the sheet at the same rate as the energy is put in by the particles, then it is found that the conductivity can be negative and, for electrostatic waves, the current is antiparallel to the electric field. Hence, energy can be transferred from the particles to the waves and it is found that the growth rate for the waves, and hence the rate of energy transfer, can be large. The results are given as functionals of ω and k since the dispersion relation for a thin sheet is believed to be dominated by the conditions outside the sheet. (auth)

16897 SOME EFFECTS OF FINITE ELECTRIC CONDUCTIVITY ON SOLAR FLARE-INDUCED INTERPLANETARY SHOCK WAVES. Dryer, Murray (Tel Aviv Univ., Israel). Cosmic Electrodyn.; 1: 348-70(Dec 1970).

The similarity solution for constant velocity "piston-driven" shock waves found by Lee and Chen for hydromagnetic shock waves in the solar wind is extended to include finite electrical conductivity. Attention is directed to some effects expected at the contact surface or ("piston") where anomalous conductivity is hypothesized. It is found that Joule dissipation and magnetic diffusion prevent the temperature and pressure from falling to zero, as given by the solution for infinite conductivity. The anomalous electrical conductivity required for this physically more realistic result is estimated to be about seven to eight orders of magnitude lower than the classical collisional value. Values of electrical conductivity much higher than these figures produce effects that are too weak and also produce physically unrealistic results at the piston face. It is, therefore, hypothesized that strong turbulence induced by wave-particle interactions is present between the driving plasma cloud and the interplanetary shock wave that precedes it. (auth)

16898 FINITE CONDUCTIVITY AND INTERPLANETARY PISTON-DRIVEN SHOCK WAVES. Eviatar, Aharon; Dryer, Murray (Tel Aviv Univ., Israel). Cosmic Electrodyn.; 1: 371-9(Dec 1970).

The question of the use of anomalous finite conductivity in numerical studies of shock-wave propagation in the solar wind is considered. It is shown that, while binary Coulomb encounters lead to effectively infinite values of this parameter, interactions between thermal electrons and ion plasma waves can cause a reduction in effective conductivities by several orders of magnitude. On this basis, the use of finite values of the parameters to obtain physically meaningful results in fluid continuum studies is justified. (auth)

16899 NONLINEAR EVOLUTION OF THE TEARING INSTABILITY IN THE GEOMAGNETIC TAIL. Biskamp, D. (European Space Research Inst., Frascati, Italy); Sagdeev, R. Z.; Schindler, K. Cosmic Electrodyn.; 1: 297-310(Dec 1970).

The nonlinear evolution of the tearing instability is considered in the framework of quasi-linear theory. It is shown that quasi-linear diffusion will lead to a velocity anisotropy, which stabilizes the tearing instability at a very small level of the tearing turbulence. The corresponding anisotropy is too small to drive the Fried-Weibel mode. The effect of an equilibrium magnetic field component transverse to the sheet and the dynamics of single modes are discussed qualitatively. It is concluded that the tearing instability can lead to small-scale turbulence in the neutral sheet; nonlinear effects, however, will prevent the sheet from undergoing gross destruction. This is consistent with observations in the geomagnetic tail. (auth)

16900 AERONOMIC CHARACTERISTICS OF D REGION AND ENERGETIC SPECTRA OF IONIZING RADIATION. Nestorov, G. (Geophysical Inst., Sofia). Compt. Rend. Acad. Bulg. Sci.; 23: 1207-10(1970).

A more exact determination of the basic parameters of the ionospheric D region during solar flares is now possible from a new aeronomic analysis method. An analysis was made from

satellite data taken during the Oct. 22, 1969 solar flare in the active period. The normal D-region data were first calculated, and then the data were calculated in relation to the solar flare data. The form and amplitude of the flare spectrum derived from ionospheric data are very close to the spectra known from literature that are obtained from rocket and satellite measurements with photon counters. (J.C.W.)

16901 STATE OF RESEARCH ON THE AERONOMY OF THE IONOSPHERIC E AND D REGIONS (REVIEW). Ivanov-Kholodnyi, G. S. Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 301-12(1970).

Translated from Geomagn. Aeron.; 10: 385-401(1970).

The specific aspects of the aeronomy of the E and D regions serve to explain the observed behavior of electron density, ionic composition, effective recombination coefficient, and changes under various conditions. The D region is characterized by the presence of negative ions. Common aspects of the two regions are 1) known production rates of primary ions appearing under the effect of short-wave solar radiation; 2) the clarification of the special role of the small components of the neutral atmosphere in the transformation of primary ions; and 3) taking into account in the theory of ionization the dynamics of the atmosphere and the vertical transport of matter. The present status of the theory of ionization of the E region and the upper D region is reviewed. 111 references. (J.C.W.)

16902 INFLUENCE OF THE ATMOSPHERE ON THE LONGITUDE DEPENDENCE OF ELECTRON INTENSITY IN THE VICINITY OF AN ANOMALY. Gorchakov, E. V.; Timofeev, G. A. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 331-4(1970).

Translated from Geomagn. Aeron.; 10: 423-7(1970).

The longitude dependence of electron intensity in the vicinity of an anomaly produced by Coulomb interactions with the medium is analyzed. It is demonstrated that the intensity of electrons with $E \sim 1$ MeV depends significantly on longitude for drift trajectories that sink to small heights in the anomaly. No significant asymmetry of intensity with respect to the center of the anomaly was discovered. (auth)

16903 ROLE OF LOW-ENERGY PLASMA IN MAGNETOSPHERIC SUBSTORMS AT THE SYNCHRONOUS ORBIT. Young, David Thad. Houston, Tex.; Rice Univ. (1970). 235p. University Microfilms Order No. 70-23,597.

Thesis.

Recent theories of the magnetospheric substorm suggest that the tail plasma sheet together with the magnetic neutral sheet embedded in it may be responsible for the substorm process (although the ultimate driving force is recognized to be the solar wind) by creating an unstable configuration inside the magnetosphere prior to the onset of the substorm. The substorm may then be viewed as a relaxation process through which the magnetosphere attempts to return to its quiescent state. The results presented herein are in substantial agreement with this concept of the magnetospheric substorm. The Suprathermal Ion Detector (SID) experiment on board the ATS-1 satellite is inferred to have encountered particle fluxes due to the presence of the tail plasma sheet at 6.6 R_E on fully 75% of its passes through the region of local midnight. There is evidence from both the SID and the ATS-1 magnetometer experiment that the tail neutral sheet rather than a partial ring current is the dominant factor in determining the geomagnetic field configuration at 6.6 R_E both before and during substorms. (TSS) (Diss. Abstr. Int., B)

16904 STUDIES OF COINCIDENT SOLAR, INTERPLANETARY, AND TERRESTRIAL PHENOMENA WHICH PRECEDE CERTAIN GEOMAGNETIC STORMS. Adkison, Hollis Leon J. Forth Worth, Tex.; Texas Christian Univ. (1970). 120p. University Microfilms Order No. 70-24,563.

Thesis.

Studies are made of solar, interplanetary, and terrestrial phenomena prior to each of the geomagnetic storms that occurred during a 14-month period of minimum solar activity. There are sufficient data available to suggest a model or mechanism by which energy capable of producing storms and other geomagnetic-field changes is transferred from the Sun to the Earth. Furthermore, there exists a characteristic activity at mid-geomagnetic latitudes that precedes and thus apparently predicts some of the storms. Analysis shows this activity, termed a precursor, to be more than coincidental and to fit into a proposed model of solar–terrestrial energy transfer and storm generation. The precursor, occurring in association with a polar magnetic substorm, is attributed to an ionospheric–magnetospheric current system. Relationships are given between the fine structure of the precursor and the time to—and characteristics of—the associated storm. (Diss. Abstr. Int., B)

16905 NO_2^+ AND O_2^+ IONS IN THE LOWER IONOSPHERE AND CORPUSCULAR IONIZING RADIATION. Tulinov, V. F. Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 423-5(1970).

Translated from Geomagn. Aeron.; 10: 538-40(1970).

The number of NO^+ and O_2^+ ions in the lower ionosphere is correlated with existing experimental data, but considering all the principal ionizing sources, data are still not in good agreement with theories. Details of existing data at 70 to 95 km are studied for the appearance and disappearance of the ions NO^+ and O_2^+. The inclusion of an assumed value of corpuscular radiation as an additional ionizing agent in the lower ionosphere makes it possible to eliminate the difficulties in interpreting the data of direct measurements of the ion concentrations. (J.C.W.)

16906 SEASONAL ANOMALY OF THE F2 LAYER AND CORPUSCULAR RADIATION. Boenkova, N. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 425-7 (1970).

Translated from Geomagn. Aeron.; 10: 541-2(1970).

The behavior of the seasonal anomaly is discussed on the basis of data from 120 stations in a period of high solar activity in 1958 and from 70 stations in a period of low solar activity in 1964 at all hours of the day. The study was divided into global distribution of the duration of the seasonal anomaly during the day for low and high solar activity. A map from Cosmos-17 data (1963) is cited as confirmation of the connection between regions of no seasonal anomaly and electron streams. The location is in a region of increased particle intensity in the Southern Hemisphere resembling the location of the region of no seasonal anomaly. It appears that the absence of a seasonal anomaly especially during high solar activity, is local, and, in all probability, is determined by the effect of corpuscular streams in the F2 layer. (J.C.W.)

16907 FORECASTING f_0F2 USING EXPANSION IN NATURAL ORTHOGONAL COMPONENTS. Dvinskikh, N. I.; Naydenova, N. Ya. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 427-30(1970).

Translated from Geomagn. Aeron.; 10: 543-6(1970).

The data from the ionospheric stations at Irkutsk for 1948–1967 and at Tomsk for 1936–1967 were used for forecasting the diurnal behavior of f_0F_2 at different points, based exclusively on the statistical properties of the time series of f_0F_2. The empirical function represents a combination of the diurnal behaviors of the monthly meridian f_0F_2 values for a given point over several years and is expanded in a series of natural orthogonal functions. The process of forecasting f_0F_2 can be divided into: (1) expansion of the diurnal patterns of the monthly median values of f_0F_2 over a number of years from a single station in natural orthogonal components; (2) a second expansion of each of the coefficients of the first expansion; (3) determination of the coefficients of the second expansion for the investigated year by solving an overdetermined system of equation, constructed from equations for the unknown months of the year; and (4) computation of f_0F_2 from a formula combining the empirical function equation and the expanded time-series equation. (J.C.W.)

16908 CHANGES IN N(h) PROFILE DURING POSITIVE IONOSPHERIC DISTURBANCES IN YEARS OF MAXIMUM AND MINIMUM SOLAR ACTIVITY. Goncharova, E. E.; Zevakina, R. A.; Lavrova, E. V.; Yudovich, L. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 430-2(1970).

Translated from Geomagn. Aeron.; 10: 547-8(1970).

Thirteen positive disturbances were recorded in Moscow in 1958–1959 and 13 in 1964–1965. Of these, 22 occurred before magnetic storms, 2 during storms, and 2 were not accompanied by magnetic storms. Thus, positive disturbances were observed mainly before magnetic storms. For determining how the N(h) profiles change during positive disturbances at different latitudes, it is shown that an increase in electron density in the F region at low latitude is accompanied by an increase in the height of the ionization maximum h_m. The change of the N(h) profile is investigated in the latitude range 80°N to 12°S during two positive disturbances observed during maximum and minimum solar activity. Enhanced absorption was observed in the auroral zones simultaneously with the increase of ionization in the F region. The highest N values were observed at equatorial latitudes and in the auroral zone on quiet days in the polar region during the positive disturbance. The most significant increase of ionization in the polar region testifies to the corpuscular nature of positive disturbances. (J.C.W.)

16909 METHOD OF DETERMINING THE ELECTRON DENSITY DISTRIBUTION IN THE IONOSPHERE. Kutiev, I. S. (Geophysical Inst., Sofia). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 433-4(1970).

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Translated from Geomagn. Aeron.; 10: 549-50(1970).

The problem of determining the vertical distribution of electron density in the ionosphere reduces to determining the integrand of the virtual reflection height h' in an expression where h is the reflection height of a wave with frequency f; u' = c/vg is the group refractive index; and vg is the group velocity. The expression is h'(f) = integral from o to h (u' dh'). After developing the system of equations for determining h(f), the advantages are listed. This method permits use of the information of the two magnetoionic components h'_o and h'_x. A number of generalized possibilities and a refinement of N(h) profiles are achieved. (J.C.W.)

16910 EFFECTIVE ELECTRON COLLISION FREQUENCY IN THE AURORAL IONOSPHERE. Osipov, N. K.; Pivovarova, N. B. (Radio Engineering Inst., Moscow. Inst. of Cosmophysical Investigations and Aeronomy, Irkutsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 434-5(1970).

Translated from Geomagn. Aeron.; 10: 551-2(1970).

The recording, on an AIS ionosonde, of the frequency dependence of the reflection coefficient of an electromagnetic wave from the ionosphere near the critical frequencies permits the mean values of the effective electron collision frequency in sporadic formations of the auroral ionosphere to be determined. Since the heights of the electron density maxima of sporadic formations range from 110 to 140 km from case to case, the results of observations of sporadic formations over a sufficiently long period allow the construction of height dependence of the effective collision frequency for the E region of the auroral ionosphere. The results of a determination of the mean values of the effective collision frequencies from observations in Tixie from Sept. to Nov. 1967 are shown. (J.C.W.)

16911 STRUCTURE AND PARAMETERS OF SPORADIC FORMATIONS IN THE AURORAL IONOSPHERE. Osipov, N. K.; Pivovarova, N. B.; Chiryaev, A. G. (Radio Engineering Inst., Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Leningrad. Inst. of Cosmophysical Investigations and Aeronomy, Irkutsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 436-7(1970).

Translated from Geomagn. Aeron.; 10: 553(1970).

The results of special ionospheric measurements, conducted at night during the winters of 1965–1967 at the Tixie station, are discussed with references to the sporadic formations associated with quiet auroras. The Epstein model was used in the analysis of the results of the measurements at a variable frequency near the critical to describe the vertical distribution of electron density in the E region. Sporadic formations frequently change from one type to another. Results indicate an interrelation between the macroscopic parameters of the sporadic formations of the E region of the auroral ionosphere and their fine structure. The internal structure becomes more complex as the height of the electron density maximum decreases. Such an effect may be influenced by the altitude dependence of the natural frequencies of the different plasma-oscillation modes in the ionosphere on the processes involved in the formation of the fine structure of the ionosphere when electron streams interact with a partially ionized atmosphere. (J.C.W.)

16912 POLARIZATION SPLITTING OF THE SPECTRUM OF ALFVEN OSCILLATIONS OF THE MAGNETOSPHERE. Gul'el'mi, A. V. (Inst. of Terrestrial Physics, Moscow. Geophysical Observatory, Borok, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 409-11(1970).

Translated from Geomagn. Aeron.; 10: 524-5(1970).

Alfven oscillations of specific models of the magnetosphere are investigated. It is shown here that the characteristic frequencies of EW and NS oscillations of one and the same magnetic shell are displaced with respect to each other, wherein the magnitude of the displacement decreases rapidly as the number of the harmonic increases. The magnetosphere is assumed to be axially symmetric and an orthogonal system of coordinates is introduced, such that the coordinate lines are the magnetic lines of force, lie in the meridional planes, and are concentric circles in the equatorial plane. The formula for the splitting of the spectrum is derived and it is shown that the frequency of EW oscillations is somewhat higher than that of NS oscillations. This splitting of the spectrum decreases rapidly with the increase in the number of the harmonic. The reliability of the information obtained can be checked against measurements of the nonequidistance of the harmonics of Alfven oscillations of the magnetosphere in works by Troitskaya and Gul'el'mi (NSA 22: 17512). (J.C.W.)

16913 DETERMINATION OF PLASMA DENSITY IN THE MAGNETOSPHERE FROM THE PERIODS OF GEOMAGNETIC PULSATIONS. Namgaladze, A. A. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 411-13(1970).

Translated from Geomagn. Aeron.; 10: 526-8(1970).

Plasma density in the magnetosphere is computed from the observed latitude dependence of the periods of geomagnetic pulsations (mainly Pc5). It is assumed that geomagnetic pulsations with periods of several minutes are caused by toroidal oscillations of the magnetosphere for which the periods are determined from an equation where the integration is carried out along a line of force and density values are not in good agreement with other experimental data. A known expression is derived that gives the relation between the value of the period of oscillations of a given line of force and the value of the plasma density at its apex. The geomagnetic field can be approximated by a dipole field with sufficient accuracy to distances up to L = 4, and the known expression is applicable to pulsations observed at geomagnetic latitudes up to 60°. The latitude dependence of the period of toroidal oscillations corresponding to the equatorial profile of the magnetospheric plasma density is computed and agrees well with the observations. The known expression derived is not applicable for determining the plasma density from periods of Pc5 pulsations observed at high latitudes. (J.C.W.)

16914 THEORETICAL SHAPE OF THE MAGNETOSPHERE OF A NONDIPOLE GEOMAGNETIC FIELD. Rudneva, N. M.; Rogovaya, S. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 415-16(1970).

Translated from Geomagn. Aeron.; 10: 530-1(1970).

Equations are derived that determine the meridional cross section of the magnetosphere containing the Sun–Earth direction, but the geomagnetic field is given by a larger number of terms of the series of the spherical harmonics of the potential. Equations are written for 0, 12, 6, 18 h UT; in setting up these equations the geomagnetic field is defined in terms of the coefficients of only the first harmonic of the spherical harmonic analysis and in terms of the coefficients of the first and second harmonics. This makes it possible to separate the effect of the inclination of the dipole and the nondipole part of the boundary of the magnetosphere. The solutions of the equations were obtained on a computer by the approximate Runge–Kutta method. (J.C.W.)

16915 CONCERNING AN ADDITIONAL IONIZATION SOURCE IN THE E REGION OF THE IONOSPHERE. I. Korsunova, L. P.; Ivanov-Kholodnyi, G. S. (Inst. of Applied Geophysics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 416-17(1970).

Translated from Geomagn. Aeron.; 10: 532(1970).

Measurements of electron density by ground-based vertical soundings at Irkutsk in summer, 1968, and rocket experiment results in summers, 1957–1960 are used to study an additional ionization source in the ionospheric E region during maximum solar activity. Results show that at E-region heights and for large zenith angles of the Sun ($Z_\odot \geq 75°$) the additional source makes the main contribution to ionization at $h \approx 100$ to 110 km. The strength of the source generally depends on the solar activity level. (J.C.W.)

16916 F1 LAYER IN A NONSTATIONARY MODEL. Klimov, N. N.; Shchepkin, L. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 417-20(1970).

Translated from Geomagn. Aeron.; 10: 533-5(1970).

Equations for model ionospheric conditions are applied to a nonstationary model corresponding to conditions under which there is an F1 layer near noon in summer. Parameters must be chosen in such a way that an extremum of N(h) is obtained in the height range 160 to 200 km. Equations include the parameters of electron density; total rate of production of O^+, N_2^+, and O_2^+ ions due to photoionization; concentration of molecular ions NO^+ and O_2^+; total rate of production of N_2^+ and O_2^+ ions; diffusion coefficient expression including ionic temperature; magnetic dip angle; concentration and temperature of neutral particles; total rate of absorption of energy of the electron gas by ions and neutral particles; coefficient of thermal conductivity, specific heat, and scale height of electron gas; and rate of heat transfer to electron gas. The model assumes that all N_2^+ and O_2^+ ions contribute to the total number of molecular ions. (J.C.W.)

16917 ESTIMATE OF THE VIBRATIONAL TEMPERATURE RELAXATION TIME OF NITROGEN MOLECULES IN THE IONOSPHERE. Klimov, N. N.; Krinberg, I. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 420-2 (1970).

Translated from Geomagn. Aeron.; 10: 536-7(1970).

The relaxation time after which the vibrational temperature can approach the electron temperature because of the collisions of N_2 molecules with thermal electrons is estimated. The excitation of vibrational levels by fast photoelectrons and by radiation, the inverse-electron impact quenching and vibrational quantum emission processes, and transitions between different excited levels

are ignored. Information on the process probabilities is limited. The reaction $O^+ + N_2 \rightarrow NO^+ + N$ contributes significantly to the formation of NO^+ ions in the F region. A study of the rate at which this reaction proceeds showed that the reaction rate coefficient γ depends strongly on the vibrational temperature T_* of molecular nitrogen. An expression is given permitting the dependence of γ on the electron temperature T_e, under the assumption that the N_2 vibrational temperature is equal to the temperature of the surrounding electrons (i.e., $T_* = T_e$). (J.C.W.)

16918 CONTRIBUTION TO THE METHOD OF INVESTIGATING IONOSPHERIC DRIFTS. Kashin, A. A.; Mirkotan, S. F.; Rybal'chenko, V. G. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 368-71(1970).

Translated from Geomagn. Aeron.; 10: 467-72(1970).

The possibilities of using the method of similar fadings to determine drift velocity, that fluctuates in the course of an observation session, are examined. A criterion of applicability is established and the error of the method is estimated. Statistical data are presented on the real fluctuations of the absolute speed and direction of drift. The error introduced by the method of similar fadings is compared with the magnitude of drift velocity fluctuation. (auth)

16919 SOLAR ACTIVITY, EARTH'S PRESSURE FIELD, AND ATMOSPHERIC CIRCULATION. Sarukhanyan, E. I.; Smirnov, N. P. (Inst. of Biology of Interior Waters, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 390-2(1970).

Translated from Geomagn. Aeron.; 10: 496-500(1970).

The results of investigations of the response of the Earth's pressure field and of atmospheric circulation to sudden changes in solar activity and its oscillations in the 11-year and secular cycles are analyzed. It is shown that, with an increase in solar activity, atmospheric pressure increases in the region of stationary low-pressure systems, causing their filling, while in the region of the high-pressure systems it decreases, inhibiting the formation of anticyclonic circulations. Therefore, during periods of high-solar activity the zonal character of the atmospheric circulation is disrupted and meridional processes are enhanced. (auth)

16920 VARIATIONS OF FREQUENCY OF OCCURRENCE OF Pc1 AT MIDDLE LATITUDES. Vinogradova, V. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 393-5(1970).

Translated from Geomagn. Aeron.; 10: 501-4(1970).

Diurnal, annual, and 11-year variations in the frequency of occurrence of Pc1 are studied from the data of Irkutsk over the period 1957–1967. (auth)

16921 STATISTICAL CHARACTERISTICS OF ANOMALOUS GRAVITATIONAL AND MAGNETIC FIELDS. Lugovenko, V. N.; Soroka, A. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 401-4(1970).

Translated from Geomagn. Aeron.; 10: 513-18(1970).

The autocorrelation functions of the anomalous gravitational field are computed for five profiles in the ocean. These functions are compared with analogous functions for continents. A comparison of the statistical characteristics of the anomalous gravitational and the anomalous magnetic fields leads to some interesting conclusions regarding the Mohorivičić discontinuity and the position of the Curie isotherm. (auth)

16922 ELECTRIC FIELD IN THE EARTH'S IONOSPHERE AND MAGNETOSPHERE IN THE PRESENCE OF A FAST-PARTICLE INHOMOGENEITY. Tsedilina, E. E. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 318-25(1970).

Translated from Geomagn. Aeron.; 10: 408-16(1970).

The solution of the equation for the electric field is analyzed. The results of numerical computations are presented. It is shown that the electric field distribution becomes complex as soon as an inhomogeneity of fast electrons and ions appears in the Earth's magnetosphere and ionosphere. The structure of the field is nearly quadrupole. The electric field rapidly decreases in magnitude. (auth)

16923 'DEFORMATION VELOCITY OF THE SOLAR WIND, LARGE-SCALE VARIATIONS OF THE INTERPLANETARY MAGNETIC FIELD, AND THE Kp INDEX OF MAGNETIC ACTIVITY. Ivanov, K. G.; Mikerina, N. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 326-30(1970).

Translated from Geomagn. Aeron.; 10: 417-22(1970).

It is found that for most plasma flows observed by space probes the variations in deformation velocity are parallel to the variations of the interplanetary magnetic field and the variations of the K_p index. It is also demonstrated that, as a rule, the maxima of the K_p index and of the deformation velocity precede the maxima of flow velocity. (auth)

16924 VERTICAL DISTRIBUTION OF THE STORM EFFECT IN THE TOPSIDE OF THE IONOSPHERE. Fatkullin, M. N.; Legen'ka, A. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 341-7(1970).

Translated from Geomagn. Aeron.; 10: 435-42(1970).

Alouette data are used to investigate the storm effect in the outer ionosphere around noon for the magnetic storm of September 14, 1963. Regions of negative and positive disturbances in electron density n_e are determined. It is shown that negative disturbances in n_e are observed only where the magnetic dip is in the range $32°N < I \lesssim 74°N$, and that the thickness of the region of negative n_e disturbances changes with latitude. The greatest heights of the transition level from negative to positive n_e disturbances are found at $I \approx 50°N$ for the given storm. (auth)

16925 CASES WHEN THERE IS NO F LAYER AT HIGH LATITUDES IN THE EARTH'S IONOSPHERE. Fatkullin, M. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 348-50(1970).

Translated from Geomagn. Aeron.; 10: 443-6(1970).

Several cases when the topside sounder Alouette I did not detect an F layer at high latitudes in the ionosphere (condition G) are described. (auth)

16926 POSSIBILITY OF NARROWING THE INTERVAL OF INDETERMINACY OF IONOSPHERIC REACTION CONSTANTS BY INTRODUCING AN ADDITIONAL CONDITION. Koshelev, V. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 351-4(1970).

Translated from Geomagn. Aeron.; 10: 447-50(1970).

The possibility of limiting the indeterminacy of the reaction rate constants, associated with the ambiguous solution of the system of differential equations, is demonstrated. (auth)

16927 INFLUENCE OF THE SOLAR ECLIPSE OF MAY 20, 1966, ON THE IONOSPHERIC E REGION. Serafimov, K.; Taubenheim, J. (Geophysical Inst., Sofia. Heinrich Hertz Institut, Berlin). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 355-62 (1970).

Translated from Geomagn. Aeron.; 10: 451-60(1970).

The variations in maximum electron densities in the E layer during the solar eclipse of May 20, 1966, are analyzed from the data of Bulgarian stations, Sofia and Michurin. The variations of the effective recombination coefficient in the control period and during the eclipse are determined ($\alpha = (6 \text{ to } 11) \times 10^{-8}$ cm^{3}sec^{-1}). It is found from a comparison of ionospheric data with corresponding satellite, radio, and optical observations that 27% of the entire ionization is due to the radiation of the corona, which generally follows the distribution of the green coronal line 5303-Å. The other 70% is approximately evenly distributed over the solar disc. Soft x radiation from local sources can exceed substantially the high background of the homogeneous disc only when these sources approach the solar limb. (auth)

16928 BALANCE EQUATIONS AND THE STATE OF RESEARCH ON CHARGED PARTICLES IN THE STRATOSPHERE AND MESOSPHERE. Bragin, Yu. A. (Novosibirsk State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 363-7 (1970).

Translated from Geomagn. Aeron.; 10: 461-6(1970).

Relatively complete balance equations of charged particles are presented for the stratosphere and mesosphere. The state of research on the composition of the particles and processes leading to their formation and disappearance is described briefly. (auth)

16929 ORIGIN OF ELECTRIC FIELDS IN THE POLAR IONOSPHERE. Vakulin, Yu. I.; Pivovarov, V. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 437(1970).

Translated from Geomagn. Aeron.; 10: 554(1970).

A nearly linear relationship between magnetic disturbance and auroral luminosity was obtained from simultaneous photometric and magnetic data in a period of auroral activity. The ionospheric parameters (recombination coefficient and collision frequency) were assumed to be constant. The conclusion from this relationship is that the ionospheric electric field during auroras depends on the parameters of the injected streams, namely, $E \sim \sqrt{j_n}$. (auth)

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16930 QUANTITATIVE CHARACTERISTICS OF MULTIPATH PROPAGATION. Barabashov, B. G. (Rostov State Univ., Rostov-on-Don, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 438-9(1970).

Translated from Geomagn. Aeron.; 10: 555(1970).

Distortion, caused by multipath ionospheric propagation of short radio waves, greatly impairs the operation of communications equipment. Multipath propagation in the short radio-wave band is analyzed with the aid of the special multipath reduction factor MRF. It is the ratio of the lowest frequency, for which the necessary degree of screening of echo signal is achieved, to the highest allowable communications frequency MUF. If the allowable group-delay time is reduced then, in some cases, multipath propagation cannot be satisfactorily described by the MRF. Results of experimental studies of short-wave multipath propagation processes along longitudinal tracks, 1000 and 1650 km long, conducted since 1967 are analyzed. MRF presents some drawbacks. For a more effective quantitative analysis of multipath propagation, it is advisable to introduce the multipath propagation coefficient MPC which, unlike the MRF, is defined as the ratio of the sum of the frequency bands for which the relative group-delay time is greater than a certain allowable value, to the difference between the highest and lowest frequencies used. (J.C.W.)

16931 DISTRIBUTION OF THE DISTURBANCE VECTORS OF NEGATIVE GEOMAGNETIC BAYS AT MID-LATITUDES. Litinskii, V. M. (Geophysics Inst., Lvov). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 439(1970).

Translated from Geomagn. Aeron.; 10: 556(1970).

At midlatitudes, the negative bays in H compromise about 10 to 15% of their total number. The bay observed at 10–11 hr UT on Mar. 23, 1958, occupies a special place in that its vector distribution resembles that for positive bays, but the center of the current vortex is located at about 30°N; therefore the bay is negative at latitudes above 30°. A comparison of the latitudinal distribution of the absolute values of the amplitudes of positive and negative bays showed that they all have minimum values at low latitudes and maxima at high latitudes. No bays are influenced by the equatorial ring current. The longitudinal distribution of positive bays in Europe is characterized by a decrease in amplitude from west to east. Thus, negative bays at mid-latitudes have a spatial distribution of amplitudes that is similar to that for positive bays, but the vector distributions can exhibit significant differences. (J.C.W.)

16932 DIURNAL VARIATION OF THE DIRECTION OF THE POLARIZATION AXIS OF Pc1 PULSATIONS. Vinogradov, P. A.; Vinogradova, V. N.; Gorin, V. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 440-1(1970).

Translated from Geomagn. Aeron.; 10: 557(1970).

The diurnal variation of the major axis of the Pc1 polarization ellipse shows that at Sogra and Irkutsk stations the direction of the axis changes at 5 to 8 hr. In the evening and at night the Pc1 polarization axis is directed toward the northwest; early in the morning, primarily toward the north; and during the day, toward the north–northeast. The existence of only the morning reversal of the sign of the deviation angle of the major axis of the polarization ellipse from the magnetic meridian has been established experimentally. It has been postulated that a second reversal exists in the evening at 17 to 20 hr. The interval from 17 to 20 hr represents the minimum in the distribution curve of the diurnal frequency of appearance of Pc1 by Vinogradova. A record obtained of such a Pc1 between 1600 and 1830 hr on Dec. 26, 1968 is analyzed. A rigorous division of Pc1 into simple and complex series is possible only through sonographic analysis of recordings on magnetic tape, and the present analysis was limited to a simple analysis of photo-optical Pc1 recordings in analog form. (J.C.W.)

16933 FINE STRUCTURE OF Pc1-TYPE MICROPULSATIONS. Feygin, F. Z.; Yakimenko, V. L. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 441-3 (1970).

Translated from Geomagn. Aeron.; 10: 558-60(1970).

The appearance of the Pc1-type geomagnetic micropulsations (pearls), propagating along geomagnetic lines of force, can be explained by a cyclotron instability in the radiation belts, caused, for example, by anisotropy in the velocity of the energetic protons. The distribution function is given when the distribution of these protons is Maxwellian with a temperature anisotropy. The structural elements of the pearl sonograms, determining the time dependence of the carrier frequency, must be in the form of slanted line segments, with the slope decreasing with time as t^{-1}; the dynamic spectrum is fan-shaped. The slope of these lines does not always decrease with time during the recording of the pearls. It is often concluded that the different forms of the dynamic spectrum must correspond to different mechanisms of pearl generation. It is shown that it is possible, in principle, to explain the different forms of the spectrum, assuming that the pearls are generated as a result of cyclotron instability. (J.C.W.)

16934 INTENSITY VARIATION OF ATOMIC OXYGEN RED LINE IN THE DAY AIRGLOW WITH SOLAR ACTIVITY. Gupta, Shashi K. (Univ. of Allahabad, India). Astrophys. Space Sci.; 9: 97-108(Oct 1970).

Rates of production of $O(^1D)$ atoms in the upper atmosphere by photodissociation of O_2, dissociative recombination of O_2^+, NO^+, and electron impact excitation of $O(^3P)$ were calculated for low, medium, and high levels of solar activity. Variations with solar activity of neutral and ionic composition, electron and neutral temperatures of the upper atmosphere, and solar extreme ultraviolet fluxes incident on it were taken into consideration. Emission rates of O I red line (6300 Å) were computed, taking into account the deactivation both by molecular oxygen and nitrogen. It is shown that the integrated intensity from low- to high-activity period varies by approximately an order of magnitude, in agreement with the results of experimental observations. (auth)

16935 PRESSURE BALANCE ACROSS THE DISTANT MAGNETOPAUSE. Mihalov, J. D.; Feldman, W. C.; Sonett, C. P.; Wolfe, J. H. (Ames Research Center, Moffett Field, Calif.). Cosmic Electrodyn.; 1: 389-96(Dec 1970).

The correspondence between field magnitude changes in the distant geomagnetic tail and changes in the exterior solar wind plasma suggests that there is pressure balance across the tail boundary (magnetopause). (auth)

16936 VERY-LOW-FREQUENCY ELECTRIC FIELDS IN THE INTERPLANETARY MEDIUM: PIONEER 8. Siscoe, G. L. (Univ. of California, Los Angeles); Scarf, F. L.; Green, I. M.; Binsack, J. H.; Bridge, H. S. J. Geophys. Res.; 76: 828-44(1 Feb 1971).

Pioneer 8 observations of magnetosheath and interplanetary vlf electric fields, consisting of hourly ranges of the potential amplitude in a broadband channel (0.1 to 100 kHz) and in a 15% bandpass channel centered on 400 Hz, are presented. Significant signals are correlated with position with respect to Earth, and with solar-wind plasma parameters obtained from the lunar-orbiting Explorer 35 spacecraft. Two principal features are: noise bursts or spikes with duration less than approximately 10 sec, and persistent signals with durations typically one day or more. The noise bursts coincide with plasma and magnetic-field discontinuities where these data are available for comparison. The persistent signals correlate loosely with solar-wind density, and this correlation holds whether the density increases are due to interplanetary shocks, the "snowplow" effect, or other processes. Although the experiment is too limited to provide unambiguous determination of the wave modes, at present it appears most likely that ion-acoustic waves were detected. (auth)

16937 OGO 5 OBSERVATIONS OF UPSTREAM WAVES IN THE INTERPLANETARY MEDIUM: DISCRETE WAVE PACKETS. Russell, C. T.; Childers, D. D.; Coleman, P. J. Jr. (Univ. of California, Los Angeles). J. Geophys. Res.; 76: 845-61(1 Feb 1971).

One class of waves observed in the interplanetary medium within several Earth radii of the earth's bow shock consists of discrete wave packets with amplitudes that are a significant fraction of the background magnetic field. In the spacecraft frame, these wave packets have periods of about 2.5 sec, grow rapidly in time and decay more slowly, and are left-handed with respect to the magnetic field. By using the measured solar-wind density and cold-plasma dispersion theory, however, data show that these wave packets must be right-handed in the plasma frame at frequencies from about 2 to 4 times the proton gyrofrequency. The propagation vector of these waves is found to point away from the Earth's bow shock and to lie between the solar-wind flow direction and the average spiral field. The waves are being carried away from the Sun by the solar wind, since their velocity is less than the solar-wind speed, but they appear to be associated with the intersection of the field line with the Earth's bow shock. Since they must be generated in the solar-wind plasma, this generation may be caused by the presence of particles streaming upstream from the shock. (auth)

16938 ENERGETIC ELECTRONS IN THE MAGNETOTAIL AT 60 R_E. Meng, C.-I. (Univ. of California, Berkeley). J. Geophys. Res.; 76: 862-72(1 Feb 1971).

Energetic-electron ($E_e > 22$ keV and $E_e > 45$ keV) observations of the lunar-orbiting Explorer 35 satellite from 15 magnetotail crossings at geocentric distances of about 60 R_E are presented. The longitudinal and latitudinal distributions are shown at two different flux intensities (low fluxes and high fluxes (cutoff $J_{(E_e>22keV)} > 345$ electrons/cm^2 sec ster)). At low fluxes with the counting-rate threshold above the cosmic-ray background, the occurrence fre-

quency of energetic electrons is almost the same from the dawn side to the dusk side of the tail. The latitudinal distribution shows the occurrence frequency of energetic electrons to be highest near the solar-magnetospheric equator and gradual falling-off away from the equatorial plane. At high-flux levels ($J_{(E_e>22keV)} > 345$ electrons/cm^2 sec ster and $J_{(E_e>22keV)} > 278$ electrons/cm^2 sec ster), the distributions are strongly dependent on longitude and latitude. The occurrence frequency is much higher in the dawn side and near the equator. The region where fluxes were found least frequently is in the northern part of the tail on the dusk side. This dawn-to-dusk asymmetry appears to increase with increasing flux threshold levels. (auth)

16939 ENERGETIC ELECTRONS IN THE PLASMA SHEET OUT TO 40 R_E. Meng, C.-I.; Anderson, K. A. (Univ. of California, Berkeley). J. Geophys. Res.; 76: 873-82(1 Feb 1971).

The flux-time profiles and correlation with the local magnetic fields of energetic electrons (<40 keV) in the magnetospheric tail were studied using four months of Imp 3 data. The following results were obtained: fluxes of 10^2 to 8×10^6 cm^{-2} sec^{-1} were measured beyond $X_{se} = -20$ R_E. The energetic electrons were confined to the plasma sheet and this general characteristic is almost the same as at the Vela orbit (~18 R_E). The electrons are almost always present throughout the entire plasma sheet, including the evening side of the magnetospheric tail. There is evidence that the energetic electrons are magnetically confined in much the same way as electron fluxes nearer the Earth in the skirt and cusp regions. These regions are recognized to be part of the plasma sheet. Electron-island fluxes are recognized as results of the expansion of the plasma sheet beyond its normal boundary. (auth)

16940 PENETRATION OF MAGNETOSHEATH PLASMA TO LOW ALTITUDES THROUGH THE DAYSIDE MAGNETOSPHERIC CUSPS. Heikkila, W. J.; Winningham, J. D. (Univ. of Texas, Dallas). J. Geophys. Res.; 76: 883-91(1 Feb 1971).

Daytime high-latitude fluxes of low-energy (<1 keV) electrons and protons were observed with the soft-particle spectrometer on the polar satellite Isis 1. These fluxes occur just above the limit Λ_c of closed geomagnetic-field lines in the daytime magnetosphere. The limit Λ_c can be identified through a sharp decrease in the flux of electrons of somewhat higher energy (~10 keV). The electron-energy spectrum shows a sharp peak at about 100 to 200 eV, with a total flux of the order of 10^9 electrons cm^{-2} ster^{-1} sec^{-1} carrying an energy of a few tenths of an erg cm^{-2} ster^{-1} sec^{-1}. The electron and proton spectral shapes are shown to be similar to those in the magnetosheath, and for protons the absolute intensities are approximately equal (no absolute intensities could be found in the literature for electrons). The proton spectrum peaks at a slightly higher energy (~300 eV), again in agreement with magnetosheath observations. The proton flux is typically >10^7 cm^{-2} ster^{-1} sec^{-1} with typical energy fluxes in the range 0.01 to 0.1 ergs cm^{-2} ster^{-1} sec^{-1}. It is concluded that solar-wind plasma can penetrate to low altitudes through the high-latitude cusp in the magnetopause, which is often referred to as the neutral point. This flux is related to a number of geophysical phenomena, including magnetospheric surface currents, daytime auroras, vlf and lf emissions, ionospheric irregularities, and geomagnetic fluctuations. (auth)

16941 MAGNETOPAUSE ELECTRIC FIELD INFERRED FROM ENERGETIC PARTICLE MEASUREMENTS ON ATS 5. Bogott, F. H.; Mozer, F. S. (Univ. of California, Berkeley). J. Geophys. Res.; 76: 892-9(1 Feb 1971).

Energetic (>30 keV) proton and electron flux measurements were made at 6.6 R_E on ATS 5 during magnetopause crossings on September 29, 1969, and March 8, 1970. In each event an order of magnitude decrease in the electron flux was observed more than 200-electron gyroradii before the boundary was reached, while the proton flux remained unchanged until after the boundary crossing. To explain these data, an outward-directed electric field is assumed to have existed in a region 800 to 1000 km wide on the Earthward side of the magnetopause, creating an $E \times B$ drift oppositely directed to and greater than the electron ∇B drift, thereby excluding electrons but not protons from this region. The required electric field is about 65 mV/meter, producing a potential of about 50 kV across the boundary layer. These data are consistent with models of a closed magnetosphere and are inconsistent with a completely open magnetosphere, but they apply only during periods of extreme magnetic activity. (auth)

16942 INFLUENCE OF MAGNETOSPHERIC CONVECTION AND POLAR WIND ON LOSS OF ELECTRONS FROM THE OUTER RADIATION BELT. Brice, Neil; Lucas, Christopher (Cornell-Sydney Univ. Astronomy Center, Ithaca, N. Y.). J. Geophys. Res.; 76: 900-8(1 Feb 1971).

It is suggested that the principal loss of energetic electrons from the outer Van Allen belt occurs in the morning hours from violation of the quasi-stable trapping limit. During disturbed times when the maximum loss occurs in the early morning hours, acceleration of the particles by the convective electric field produces the violation of the stable limit. During less-disturbed times the maximum precipitation is in the late morning hours and is caused by cold-plasma flow from the ionosphere into the magnetosphere, which increases the equatorial-plasma density and decreases the magnetic energy density per particle. This reduces the particle-threshold energy for the whistler-mode instability, thus causing previously large fluxes of lower-energy electrons to become subject to the trapping limit. (auth)

16943 RAPID DIFFUSION OF ENERGETIC CHARGED PARTICLES ACROSS MAGNETIC FIELDS. Cole, K. D. (La Trobe Univ., Bundoora, Australia). J. Geophys. Res.; 76: 909-19(1 Feb 1971).

In crossed electric and magnetic fields ($E \cdot B = 0$), diffusion of energetic charged particles across the magnetic field occurs through the combination of pitch-angle scattering and the subsequent grad B drifting through the electric field. The estimated diffusion coefficient for this compound process in a magnetic field of fixed direction is given in an expression. The diffusion coefficient appropriate to a curved magnetic field is similar but has a modification for the curvature. Conditions that must be fulfilled for radial diffusion to be faster than pitch-angle diffusion are determined in both the absence and presence of an absorber (atmosphere) in a general celestial magnetic field. The conditions are specified in terms of pitch angle, electric-field strength, and magnetic-field distortion. These conditions may be met in the magnetosphere during magnetic storms for a wide range of particle energy up to 1 MeV and more. (auth)

16944 SUBAURORAL RED ARCS AND ASSOCIATED IONOSPHERIC PHENOMENA. Chandra, S.; Maier, E. J.; Troy, B. E. Jr.; Rao, B. C. Narasinga (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 76: 920-5(1 Feb 1971).

The phenomenon of the midlatitude red arc of September 29, 1967, through observations of the properties of the ionospheric plasma, is described. The ion and electron temperatures, ion composition and density, and suprathermal electron flux during this period are measured by retarding-potential analyzers near 900 km from Ogo 4 and near 2000 km from Explorer 31. These parameters show the following changes in the region L = 2.3 to 3.0 during the red-arc period, as compared with their values during normal periods: (1) electron and ion temperatures increase to above 4000°K from a normal value of 2000°K at 900 km, while at 2000 km electron temperature increases to above 5000°K from a normal value of 2500°K; (2) at 900 km the ratio of $O^+/(H^+ + He^+)$ changes from 1 to 5, while the total density remains approximately the same; (3) at 2000 km the ion density decreases by a factor of 10 with the composition remaining all H^+; and (4) there is no significant increase in the flux of 5- to 10-eV electrons. The relative importance of electric-field heating, magnetospheric conduction, and the changes in the neutral composition in the lower atmosphere are examined in the light of these observations. It is concluded that the subauroral red arc is caused by a combination of thermal conduction of energy from the magnetosphere and changes in the neutral compositions in the lower atmosphere. (auth)

16945 QUIET DAY MAGNETIC FIELD AT ATS 1. Cummings, W. D. (Grambling Coll., La); Coleman, P. J. Jr.; Siscoe, G. L. J. Geophys. Res.; 76: 926-32(1 Feb 1971).

A study of the quiet-day magnetic field at ATS 1 for the interval of January through June 1967 is presented. For each of 28 quiet days the H component (perpendicular to the equatorial plane) is Fourier-decomposed to yield approximate values for the gradient in the field of the external currents evaluated at the Earth. These gradients are used to calculate the equatorial component of the interaction force between the solar wind and the Earth. The average force for the 6-month interval was 34×10^{11} dynes. The force was directed away from the Sun–Earth line by about 12° on the average, although there was considerable variation from day-to-day. This deviation is 2 or 3 times that expected from the orbital motion of the Earth in the radial solar wind and is consistent with Walters' effect. (auth)

16946 MICROPULSATIONS IN THE Pc3- TO Pc4-PERIOD RANGE AT FOUR CANADIAN OBSERVATORIES. Gupta, J. C.; Stening, R. J.; vanBeek, G. Jansen (Dept. of Energy, Mines, and Resources, Ottawa). J. Geophys. Res.; 76: 933-46(1 Feb 1971).

Geomagnetic micropulsations in the Pc3- to Pc4-period range were recorded simultaneously from July 12 to August 16, 1968, at four Canadian stations spanning the auroral and polar regions. The records were analyzed for 2.5-min ranges and for occurrence frequency of Pc3 and Pc4. Several occurrence peaks were found. Pc3 was enhanced during the day and showed local time dependence with

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the main peaks centered on 0800 and 1100–1200 hours local geomagnetic time. The largest peaks for Pc4 were at noon, midnight, and 1600–1700 hours (all local geomagnetic time). A particularly good correlation was found between Ap and the 2.5-min ranges at all stations. Occurrence frequencies for both day and night were maximum in the auroral zone, with the nighttime Pc3 occurrence falling off rapidly on the poleward side. The correlation of Pc3 with ΣKp was good at all stations, but correlation with the daily mean of the hourly magnetic ranges at each station decreases more rapidly away from the auroral zone than does correlation with ΣKp. The correlation of Pc4 with ΣKp was much poorer and was negligible at Ottawa. Universal-time peaks were found in the disturbance variations of Pc3 and Pc4. The previously reported peak at 2000–2100 UT in Pc3 was found only in the disturbance variation. The origins of the micropulsations are discussed in terms of hydromagnetic waves traveling both along and perpendicular to field lines and originating in the Sunward magnetopause and geomagnetic-tail regions. Several observations fit into the diffuse and discrete categories of events. (auth)

16947 INTERMODE COUPLING AT ION WHISTLER FREQUENCIES IN A STRATIFIED COLLISIONLESS IONOSPHERE. Wang, Ting-i (Dartmouth Coll., Hanover, N. H.). J. Geophys. Res.; 76: 947-59(1 Feb 1971).

By starting from a consideration of intermode coupling at an interface between two anisotropic plasma media, the reflection and transmission coefficients of a normally incident plane wave can be defined as matrix quantities (the off-diagonal elements representing the intermode-coupling coefficients). The results were generalized to a stratified medium by including multiple reflections between parallel interfaces. Over-all transfer coefficients were calculated by iterative procedures. The problem of a wave upgoing in the ionosphere and passing through the crossover region ($D = 0$) at ion-whistler frequencies was analyzed by the computer. Quantitative results show that for small angles between the direction of the magnetic field and the wave-normal, intermode-coupling effects play an important role even in a collisionless plasma. For a longitudinally propagating wave, intermode coupling is zero except at $D = 0$ where critical coupling occurs. In that case, when the wave passes through the crossover region, the incident-SR (slow right-hand) wave is completely coupled to the FR (fast right-hand) wave, but the wave polarization does not change. It follows that it is impossible for a satellite to receive an ion whistler at any altitude for a longitudinally propagating wave in the collisionless ionosphere. For small angles ($\theta \leq 10°$), the intermode coupling is strong in the vicinity of $D = 0$, and the wave is dominated by the FR wave for an incident SR wave. It is thus difficult to receive ion whistlers in this case. For large angles ($\theta \geq 30°$), intermode coupling around crossover is small. The wave is dominated by the SL wave for an incident-SR wave. Since the polarization of the dominant wave changes from right-hand to left-hand, a satellite at an altitude above the crossover can receive ion whistlers. Wave-normal angles between 10 and 30° constitute a transition region between the pure electron-whistler and the uncoupled ion-whistler regimes. (auth)

16948 EXPERIMENTAL STUDY OF VERY-LOW-FREQUENCY MODE COUPLING AND POLARIZATION REVERSAL. Rodriguez, Paul; Gurnett, Donald A. (Univ. of Iowa, Iowa City). J. Geophys. res.; 76: 960-71(1 Feb 1971).

Below the proton gyrofrequency, both polarization reversal and mode coupling of the right- and left-hand modes of propagation can occur. An experimental study of polarization reversal and mode coupling of electron and proton whistlers is presented. The occurrence of polarization reversal for a whistler signal observed in the ionosphere is indicated by the presence of a proton whistler. Mode coupling between the right- and left-hand modes of propagation is indicated by the occurrence of both electron and proton whistler signals at the same frequency. Mode coupling is observed to occur most frequently over a range of about 35 to 55° magnetic latitude. Below about 35° magnetic latitude, polarization reversal is the predominant effect, whereas above about 55° magnetic latitude neither mode coupling nor polarization reversal occurs and proton whistlers are not observed. These results are compared with existing theories to explain this latitude dependence. (auth)

16949 THEORY OF THE INJUN 5 VERY-LOW-FREQUENCY POYNTING FLUX MEASUREMENTS. Mosier, Stephen R.; Gurnett, Donald A. (Univ. of Iowa, Iowa City). J. Geophys. Res.; 76: 972-7(1 Feb 1971).

The theory is presented of the vlf Poynting flux measurement technique used on the Injun 5 satellite. This technique consists of using one electric and one magnetic antenna, both oriented perpendicular to the geomagnetic field and to each other, to determine the direction of the vlf Poynting flux up or down the geomagnetic field. The conditions for which the Poynting flux direction determinations are valid are considered, including the effects of errors in the magnetic orientation of the spacecraft and the simultaneous presence of many waves. (auth)

16950 ENERGETIC-PARTICLE MEASUREMENTS IN A PULSATING AURORA. Whalen, B. A.; Miller, J. R.; McDiarmid, I. B. (National Research Council of Canada, Ottawa). J. Geophys. Res.; 76: 978-86(1 Feb 1971).

Electron and proton precipitation at energies greater than 25 keV was measured in an early morning pulsating aurora by rocket-borne particle detectors. Pulsations found in the lower-energy ($25 \leq E \leq 80$ keV) electron precipitation were in phase with ground-based photometric observations of the 3914-A emission. In the intervals between the trains of pulsations, (hard) electron and more intense (soft) proton precipitation was reasonably stable. During the pulsations large increases (factors of 4 or 5) in lower-energy electron intensities were measured, which resulted in nearly identical electron and proton spectral distributions at the pulsation peak, whereas proton and energetic ($E > 100$ keV) electron precipitation exhibited no detectable variation. Upper limits on intensity fluctuations of protons and energetic electrons were set at 5% and 10%, respectively. Lower-energy electrons were found to have anisotropic pitch-angle distributions peaked at 90° going isotropic during a pulsation and were responsible for a significant fraction of the 3914-A intensity modulation. Angular distributions of protons and energetic electrons were isotropic for the duration of the flight. These measurements indicate that auroral pulsations result primarily from increases in pitch-angle diffusion that cause large electron-precipitation enhancements in the energy range 15 to 80 keV. Certain requirements of theoretical pulsation models are discussed. (auth)

16951 ROCKET-BORNE SPECTROSCOPIC MEASUREMENTS IN THE ULTRAVIOLET AURORA: NITROGEN VEGARD–KAPLAN BANDS. Sharp, William E. (Univ. of Colorado, Boulder). J. Geophys. Res.; 76: 987-1005(1 Feb 1971).

The ultraviolet spectrum of an aurora was measured with a spectrometer that was carried by rocket into an IBC I+ aurora. Altitude profiles of the band emissions from the Vegard–Kaplan and second positive systems of N_2 were obtained. Consideration of all the excitation processes of the N_2 triplet states shows that the production of the $A^3\Sigma_u^+$ state is proportional to the production of the $C\ ^3\Pi_u$ state. The volume-emission-rate profile of the Vegard–Kaplan system deduced from the column-emission rate indicated that the system was quenched. Comparison of the volume-emission rate of the second positive and Vegard–Kaplan systems gives quenching rates for the $v' = 0$ and 1 levels of the $A^3\Sigma_u^+$ state, which vary smoothly from 100 sec^{-1} at 100 km to 0.3 sec^{-1} at 220 km. At high altitudes the most likely quenching agent is atomic oxygen, with molecular oxygen becoming important below 120 km. With the use of a model atmosphere, the coefficients for the quenching of the $v' = 0$ and 1 levels of the $A^3\Sigma_u^+$ state of N_2 by atomic oxygen are calculated to be 9×10^{-11} and 1.1×10^{-10} $cm^3\ sec^{-1}$, respectively. The ratio of quenching coefficients for atomic oxygen and molecular oxygen is 4.2. The rotational temperature of the $A^3\Sigma_u^+$ state increases with altitude. (auth)

16952 BALMER-ALPHA DISTRIBUTIONS OVER A SOLAR CYCLE: COMPARISON OF OBSERVATIONS WITH THEORY. Tinsley, Brian A. (Univ. of Texas, Dallas); Meier, Robert R. J. Geophys. Res.; 76: 1006-16(1 Feb 1971).

Observations of Balmer α made since 1958 in the USSR, Norway, France, Bolivia, and the USA were corrected for background effects and tropospheric scattering and are compared with radiative transfer calculations for exospheric temperatures ranging from 750 to 1500°K. The new calculations take into account the effects of hydrogen out to 70,000 km and are normalized to three times the Kockarts–Nicolet abundances, as required for consistency with Lyman-α measurements. They show little change with exospheric temperature, in the relative brightness distributions with solar-depression angle and azimuth with respect to the Sun. The 56:1 change in hydrogen density at 650 km for this temperature change with constant production rate results in about an eighteen-fold change in over-all brightness for a constant solar Lyman-β flux. The observed change in brightness is by a factor of about 3 after correction for background effects and implies a six-fold change in flux at the line center of solar Lyman β. Measurements of the total solar Lyman-β flux show a variation since 1961 that, when taken with a change in the self-reversal, is consistent with the required line-center solar Lyman-β change. However, the absolute intensity of the line-center flux is lower than required by a factor of 2 to 5. (auth)

16953 SEASONAL VARIATION IN THE F2 REGION. Mayr, H. G. (Goddard Space Flight Center, Greenbelt, Md.); Mahajan, K. K. J. Geophys. Res.; 76: 1017-27(1 Feb 1971).

Semiannual and annual variations in the F2 region are examined by using f_0F2 and h_m data during the descending phase of solar

activity (1958–1965). The semiannual effect appears as a persistent feature of the ionosphere which, demonstrably, is not related to fluctuations in the 10.7-cm noise or the euv radiation. This gives support to theories that attribute the semiannual effect to variations in the lower atmosphere. Although theoretically predicted temperature variations [Volland, 1969] could quantitatively account for the observed semiannual variations in the height of the F2 peak, the variations in $N_m F2$ require additionally significant variations in the neutral composition at lower heights. Evidence for this is found in rocket-borne $[OI]/[O_2]$ measurements at 120 km, which show maxima during equinox and a maximum to minimum ratio of 2 consistent with the ionospheric behavior. The annual variation in the ionosphere, showing a winter-to-summer enhancement in the F2-peak density at low latitudes and during low solar activity, can be explained by meridional winds at ionospheric heights. These winds also have a significant effect on the height of the F2 peak and appear to be effective throughout the solar cycle as evident from the ionosonde and the radar-backscatter observations at Puerto Rico, which show the peak at higher altitudes in summer than in winter. This is consistent with the observations of King et al. [1968], pointing out that the electron density in the topside ionosphere is persistently higher in the summer hemisphere than in the winter hemisphere thus suggesting that in the upper ionosphere the wind effect on the height of the F2 maximum masks the processes responsible for the winter anomaly in N_m. (auth)

16954 DECREASE IN D-REGION $O_2(^1\Delta_g)$ PHOTOIONIZATION RATES RESULTING FROM CO_2 ABSORPTION. Huffman, R. E. (Air Force Cambridge Research Lab., Bedford, Mass.); Paulsen, D. E.; Larrabee, J. C.; Cairns, R. B. J. Geophys. Res., 76: 1028-38(1 Feb 1971).

Photo-ionization of the metastable $O_2(^1\Delta_g)$ molecule has been proposed as an important source of ionization in the D region. The wavelength region of interest is from 1027 to 1118 A, where ground-state O_2 is the primary absorber of the incident solar flux but is not ionized itself. This paper presents improved ion-production rates based on new laboratory data, including new $O_2(^1\Delta_g)$ photoionization cross sections and more detailed curves in several ground-state O_2 windows. Recent solar-flux measurements reduce the continuum intensity by about a factor of 5. This reduction is partly compensated by including in the calculations the Si III multiplet, which is at the deepest O_2 window (1108.2 A, minimum cross section = 4.4×10^{-21} cm^2) and by the new ionization cross sections, which are generally larger than the previously assumed values. An important factor not previously considered is absorption by carbon dioxide, which has a much larger absorption cross section than ground-state O_2 throughout this region. The ground-level mixing ratio has been assumed. The ion production rates are somewhat less than Hunten and McElroy's [1968] curves if CO_2 is not included. With CO_2, a production rate of 1 ion cm^{-3} sec^{-1} is reached at approximately 80, 84, and 86 km for zenith angles of 0°, 45°, and 60°, respectively. Hunten and McElroy find this rate to be 10 to 15 km lower. Concentrations of O_2^+ are calculated for a zenith angle of 45° for a variety of conditions, including a dry atmosphere and an atmosphere with 5 ppM H_2O. (auth)

16955 SPLITTING OF DRIFT SHELLS BY THE MAGNETOSPHERIC ELECTRIC FIELD. Roederer, Juan G. (Univ. of Denver). J. Geophys. Res.; 76: 1055-9(1 Feb 1971).

The dawn-to-dusk magnetospheric electric field E breaks the pitch-angle degeneracy of particle drift shells in a magnetic dipole field. For particles of sufficiently large kinetic energy T, the expression for the associated radial-diffusion coefficient is $D_{LL} \approx (\mu_0^2/162)\,(qEa/T)^2\,L_0^2 D_{\mu\mu}$, where μ_0 is the cosine of the equatorial pitch angle at midnight, q is the charge, a is the radius of the Earth, and L_0 is the dimensionless shell parameter. The coefficient of pitch-angle diffusion D_{μ} is roughly half the reciprocal lifetime. In the absence of pitch-angle scattering, the electric splitting of drift shells constitutes an important adiabatic phenomenon. (auth)

16956 GENERAL EXPRESSION OF THE FREQUENCIES OF THE OBLIQUE ECHOES AT THE PLASMA RESONANCE. Graff, Philippe (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France). J. Geophys. Res.; 76: 1060-4(1 Feb 1971).

The frequencies of oblique echoes received by topside sounders at the plasma resonance are calculated without geometrical restrictions on the respective orientations of the static magnetic field, the gradient of electron density, and the satellite velocity. This work uses the WKB technique introduced by Fejer and Yu, and facilitates the interpretation of satellite data. (auth)

16957 VARIATIONS OF SOLAR WIND FLUX OBSERVED BY SEVERAL SPACECRAFT AND RELATED PULSATIONS OF THE EARTH'S ELECTROMAGNETIC FIELD. Gringauz, K. I. (Radiotechnical Inst., Moscow); Solomatina, E. K.; Troitskaya, V. A.; Shchepetnov, R. V. J. Geophys. Res.; 76: 1065-9(1 Feb 1971).

The parameters of the solar wind measured in interplanetary space are compared with characteristics of pulsations of the Earth's electromagnetic field recorded at geophysical observatories. Data covering different phases of solar activity were obtained during flights of Venera 2, 4, 5, 6, and Imp 1. The correlation of the intensity and period of continuous micropulsations and short-period disturbances of the Earth's magnetic field with solar-wind flux and other parameters is made. A clear dependence of the general intensity of micropulsations and short-period disturbances of the Earth's electromagnetic field on the solar-wind flux affecting the magnetosphere was observed on Venera flights 5 and 6, but not on Venera 4. The period of continuous micropulsations depends on the solar-wind flux, essentially independent of solar-wind velocity, and is determined only by the density of the solar wind. The nature of the dependence of the micropulsation period on the solar-wind ion flux and density leads to the suggestion that two types of pulsations may exist. (J.C.W.)

16958 COMPARISON OF EXPERIMENTAL AND GASDYNAMIC FLUID PARAMETER JUMPS ACROSS THE EARTH'S SHOCK. Dryer, Murray (Tel Aviv Univ., Israel). J. Geophys. Res.; 76: 1070-5(1 Feb 1971).

Recent plasma data obtained during several passes through the bow shock are discussed and the gasdynamic theory is discussed as applied to the data. The gasdynamic theory predicts well the gross character of the jump conditions. Since the theory is supposed to focus attention on basic physical processes rather than to compare quantitative results extensively with experimental measurements the comparison is limited in the number of events but includes all appropriate plasma parameters. It is possible to arrange various combinations of magnetopause shapes together with reasonable Mach numbers and adiabatic exponents to obtain a wide range of temperatures within the magnetosheath. The conservation of energy flux across the Earth's shock considering both electron and proton temperatures is examined from satellite shock-crossing data. The comparison with fluid theory should include the effect of the electrons and the alphas, as well, if their abundance should be appreciable. Also, the role of the interplanetary magnetic field should be considered. (J.C.W.)

16959 SOFT-PARTICLE FLUXES NEAR THE EQUATOR. Heikkila, W. J. (Univ. of Texas, Dallas). J. Geophys. Res.; 76: 1076-8(1 Feb 1971).

Observations of ionospheric low-energy electrons and protons at low latitudes were obtained by means of a soft-particle spectrometer on board Isis 1. The existence of intense fluxes of electrons and protons near the equator in the late evening is shown. The energy spectrum is broad, extending up to several keV. The pitch-angle distribution is highly anisotropic, essentially that of a trapped population with pitch angle $\alpha = 90°$. The flux of electrons with $\alpha = 90°$ on this occasion reaches 5×10^9 cm^{-2} $ster^{-1}$ sec^{-1} carrying 10 ergs cm^{-2} $ster^{-1}$ sec^{-1}, comparable with intense auroral-zone values; because of the trapped distribution, this is not the precipitated flux. Corresponding numbers for protons were about an order of magnitude lower. The source of these particles is not known and likely mechanisms for their presence are discussed. (J.C.W.)

16960 DIFFUSION OF PARTICLES IN PRESENCE OF SIMULTANEOUS VLF AND ULF ELECTROMAGNETIC WAVES. Etcheto, J.; Gendrin, R.; Lemaire, D. (Groupe de Recherches Ionospheriques, Saint-Maur, France). J. Geophys. Res.; 76: 1079-82(1 Feb 1971).

Two independent methods are shown to give approximately the same estimate for the vlf-diffusion coefficient of electrons near the loss-cone angle for the modulated precipitation event studied by Gendrin et al., 1970, during a rocket experiment made at Kerguelen Islands. Coroniti and Kennel, 1970, studied the influence of a hydromagnetic oscillation on the diffusion of electrons interacting with a vlf wave. Using the Kerguelen Island data, and the theory of Coroniti and Kennel, the methods are discussed. More precise verification requires the knowledge of the intensity and polarization of the ulf magnetic perturbation in the equatorial region and a measurement of the anisotropy of the whole electron distribution. (J.C.W.)

16961 ALOUETTE 2 OBSERVATIONS SUPPORTING THE OBLIQUE ECHO MODEL FOR THE PLASMA FREQUENCY RESONANCE. Benson, Robert F. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 76: 1083-7(1 Feb 1971).

In 1969 McAfee suggested the possibility of determining the electron temperature from the fringe pattern of the plasma resonance observed near the local plasma frequency f_N by the topside

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sounder satellites. The method is based on the oblique echo model for the plasma frequency resonance, originally proposed by McAfee, and verified by theoretical work. The theoretical study may provide the means for settling the controversy that has arisen over the disagreement between the electron temperature values deduced from satellite prove measurements and radar-scatter measurements, reported by Hanson et al., 1969. McAfee recently predicted that the plasma frequency resonance should have a significantly shorter time duration when $f_N < f_H$ than when $f_N > f_H$, where f_H is the local electron cyclotron frequency; this needs experimental verification. The sudden change in the time duration of the f_N resonance at $f_N/f_H = 1$ is verified here. Additional confirmation is the observation that the rippled structure of the f_N resonance is observed when $f_N > f_H$, but not when $f_N < f_H$. A finding that also supports the oblique echo model is the detection of the Fourier spectrum of the transmitted sounder pulse on the received resonant signal at f_N when $f_N < f_H$ but not when $f_N > f_H$ (from ionograms). (J.C.W.)

16962 ROCKET MEASUREMENTS OF UPPER ATMOSPHERIC NITRIC OXIDE AND THEIR CONSEQUENCES TO THE LOWER IONOSPHERE. Meira, Luiz Gylvan Jr. Boulder, Colo.; Univ. of Colorado (1970). 142p. University Microfilms Order No. 70-23,733.

Thesis.

The nitric oxide-density profile in the upper atmosphere was determined from the measurement of fluorescence-scattered solar radiation in the (1,0) gamma band at 2149 Å. Two sets of observations were made with scanning-ultraviolet spectrometers aboard Nike–Apache rockets. The flights were launched from Wallops Island, Va., on January 31 and February 6, 1969, with a solar-zenith angle of about 60°. Nitric oxide densities were derived for the region from 70 to 110 km. Careful consideration of the Rayleigh-scattering contribution to the observed airglow allows for an improvement over past nitric oxide measurements in the mesosphere. It is found that the nitric oxide-density profile has a maximum of about 10^8 cm^{-3} at 105 km, and a minimum of about 10^7 cm^{-3} at 85 km. From the observed densities, it is concluded that photochemical equilibrium is prevalent above an altitude between 85 and 90 km, while mixing dominates below that altitude. (TSS) (Diss. Abst. Int., B)

16963 SOLAR WIND KELVIN–HELMHOLTZ INSTABILITY OF THE MAGNETOPAUSE AND THE SEMIANNUAL VARIATION OF GEOMAGNETIC ACTIVITY. Boller, Bruce R. New York; City Univ. (1970). 188p. University Microfilms Order No. 70-24,457.

Thesis.

The characteristics of the solar wind and the developments leading up to the discovery of the magnetosphere and bow shock are presented. An equation is developed for the interplanetary magnetic field as a function of distance from the Sun. This equation reduces to the standard Archimedean spiral equation so often found in the literature in the appropriate limit. An illustrative justification of the magnetohydrodynamic equations is given. Following Chandrasekhar, an instability condition is developed for the magnetopause. It is then shown that Kelvin–Helmholtz instability along the flanks of the magnetosphere exhibits a semiannual variation with instability maxima at the equinoxes and instability minima at the solstices. The angle between the solar-wind streaming and the magnetospheric magnetic field at the flanks is shown to be the relevant parameter. The predicted behavior of the diurnal variation of geomagnetic activity on the basis of the Kelvin–Helmholtz mechanism is displayed by selected geomagnetic observatories just below the auroral regions by an analysis of their K indices. The physical mechanism of the Kelvin–Helmholtz instability at the flanks of the magnetosphere adequately explains the cause of the semiannual variation of geomagnetic activity. Consequences of this mechanism are presented and verified. (TSS) (Diss. Abstr. Int., B)

16964 ROCKET-BORNE MEASUREMENT OF AURORAL-PARTICLE CURRENTS. Vondrak, Richard Robert. Houston, Tex.; Rice Univ. (1970). 161p. University Microfilms Order No. 70-23,589.

Thesis.

A rocket-borne auroral-particles experiment was fired from Fort Churchill, Canada, over a homogeneous arc at 8 PM local time on February 26, 1969. The experiment was designed to measure the field-aligned current carried by energetic (>2 keV) auroral protons and electrons. Downward electron fluxes of about 10^8/cm^2-sec-ster-keV in the energy range 2 to 18 keV were observed as well as backscattered electron flux equal to about 20% of the downward flux in the same energy range. No protons in this energy range or higher-energy particles were found in significant quantities. The south-to-north intensity profile of the arc was roughly gaussian with a 10% intensity width of 10 km and a smaller secondary maximum to the north of the central maximum. The energetic auroral-particle current at the center of the arc at an altitude of 135 km was measured to be 1.5×10^{-5} amp/m^2. The current density integrated across the arc width was equivalent to a sheet-current density of 0.07 amp/m. It was found that the auroral electrons carry a substantial portion of the upward current but are a negligible contribution to the downward current. (TSS) (Diss. Abstr. Int., B)

16965 STUDIES OF IONOSPHERIC IRREGULARITY USING RADIO-ASTRONOMICAL TECHNIQUES. Elkins, Terence James. Boston; Boston Univ. (1970). 207p. University Microfilms Order No. 70-23,141.

Thesis.

The small-scale inhomogeneous structure of the ionospheric F region is studied using radio astronomical techniques, with radio stars and geostationary satellites as sources. The various observational techniques are examined and compared, and special emphasis is placed on the measurement of ionospheric drifts, together with the interpretation of such measurements. The principal theories for the formation and dynamics of F-region irregularities are reviewed and evaluated. The mathematical techniques, used in the study of ionospheric irregularities by radio-astronomical techniques, are reviewed, with emphasis placed on physical principles involved. The experimental data include: (i) measurements at several radio frequencies, roughly at octave intervals, of the received flux from the radio star Cassiopeia A and (ii) measurements, at a number of spatially separated points, of the vhf transmissions from several geostationary communications satellites. A substantial study of the power spectrum of ionospheric scintillations is carried out. The relationship between this spectrum and that of the F-region irregularity sizes is examined in detail. A theory is developed that involves the coupling into the F-region plasma of energy from propagating hydromagnetic waves. The dispersive properties of ionospheric irregularity motions are examined experimentally by utilizing the spatially separated observations. Attempts are made to resolve discrepancies between earlier observations of ionospheric irregularity dispersion. A section specifically concerned with measurements at very low-elevation angles is included. The statistics of propagation from a geostationary satellite, located below the geometrical horizon, are examined. A new type of experiment, which uses transmissions from nearly stationary satellites to explore the irregular properties of the troposphere, is described. The results are interpreted in terms of internal gravity waves propagating in the low troposphere. (TSS) (Diss. Abstr. Int., B)

16966 ENERGETIC ELECTRON CLOUDS IN THE EARTH'S MAGNETOTAIL AND ENVIRONS. Oliven, Melvin Norman. Iowa City, Iowa; Univ. of Iowa (1970). 363p. University Microfilms Order No. 70-23,927.

Thesis.

Explorer 33 and Explorer 35 measurements of energetic electrons $E_e \gtrsim 45$ keV in the magnetotail and other surrounding Earth regions provide the basis of a series of studies of energetic electron clouds of intensities $j \gtrsim 40$ (cm^2 sec sterad)$^{-1}$. The statistical survey of the entire body of data locates the principal region of cloud occurrence: the heart of the magnetotail with an asymmetric distribution with respect to the Sun–Earth line biased toward the dawn meridians. This study encompasses regions previously studied by other groups and extends the observable domain beyond those limits to distances >80 R_E. The occurrence of electron clouds is strongly dependent upon the Z distance from the average neutral sheet location and the angle φ_{SE} as this angle departs in either direction from the value $\varphi_{SE} \cong 185$ to 190°. No radial dependence of electron-cloud occurrence in the magnetotail is found. Identification of electron clouds on the basis of half-hour counting rate averages of the electron data confirms these findings with the additional result that the occurrence probability is proportional to the average (half-hour average) intensity of the electrons in a particular region. A slight seasonal dependence of cloud occurrence corresponding to the seasonal variation of the neutral sheet position is found. (TSS) (Diss. Abstr. Int., B.)

16967 ROCKET MEASUREMENTS OF NITRIC OXIDE IN THE LOWER D REGION OF THE IONOSPHERE. Pontano, Benjamin Anthony. University Park, Pa.; Pennsylvania State Univ. (1970). 98p. University Microfilms Order No. 70-24,187.

Thesis.

A rocket-borne probe that measures nitric oxide concentration in the D region was designed, built, and successfully flown on Sept. 22 and Dec. 6 and 12, 1968. The probe measures changes in ionization caused by photo-ionizing neutral nitric oxide with a flashing Lyman-α source. Since the sensitivity of the instrument is inversely proportional to the velocity of the probe, a parachute is deployed during descent at which time subsonic measurements are made. The experiment yielded nitric oxide densities greater than 10^8 cm^{-3} in the 40 to 63 km-altitude range. Chemical equi-

librium conditions do not explain the observed NO data. Below the mesopause, the atomic nitrogen concentration is so low that a photoequilibrium value of NO cannot be reached. Therefore, nitric oxide must be transported from the lower thermosphere, a region where atomic nitrogen is abundant, into the mesosphere and stratosphere. At the mesopause and upper mesosphere, a downward eddy diffusive flow easily accounts for a NO concentration of about 10^7 cm^{-3} in a mixing distribution. However, eddy diffusion does not explain the observed high values of NO in the lower mesosphere and stratosphere. The NO concentration in this region must be maintained by an unknown transport process. (Diss. Abstr. Int., B)

16968 DETERMINATION OF THE EMISSION STRUCTURE OF ACTIVE AURORAS WITH A MULTICHANNEL PHOTOMETER. Meriwether, John Williams. College Park, Md.; Univ. of Maryland (1970). 216p. University Microfilms Order No. 70-23,302. Thesis.

Auroral field studies centered upon the employment of a filter-wheel photometer, continuously rotating at a frequency of 10 Hz, for observations of ten auroral emissions featuring nitrogen band systems and oxygen atomic emission lines. Measurements were taken in a two-week period of observations that included two very interesting events. One, accompanied by a magnetic storm following a solar flare, manifested an unusual enhancement of 6300A (O I ^1D–^3P) that correlated with a rise in the apparent vibrational temperature of N_2. The other displayed an enormous pulse of the auroral luminosity that was coordinated with the beginning of a polar substorm. The study of the emission structure of the auroras for both events showed several enhancements that were indicative of the influence of supplementary mechanisms that are not normally active. The results of the data analysis demonstrated the great potential of the multiple photometer in the elucidation of the auroral excitation mechanisms from ground-based studies. (Diss. Abstr. Int., B)

16969 FEATURES OF TROPOSPHERIC AND STRATOSPHERIC CIRCULATION AND HIGH-ENERGY PARTICLES. Sazonov, B. I. Tr. Gl. Geofiz. Observ.; 245: 56-63(1969). (In Russian).

As a result of 10,000 meteorological rocket launchings, a great deal of data has been accumulated on circulation in the lower, 120- to 130-km layer of the atmosphere. This data is reviewed in this article, and an attempt is made to link circulation with the incidence of high-energy protons. It is noted that protons from the Sun's corona with an energy of 10^3 to 10^4 eV are absorbed in the ionosphere at heights of about 150 km. Protons with an energy of 10^5 to 10^7 eV are absorbed at 60 to 120 km, and protons with 1 to 5×10^8 eV energy are absorbed in the stratosphere at 20 to 40 km. Protons with an energy of 1 to 5×10^9 eV penetrate to the upper troposphere. The energy given off during absorption explains the existence of circulation pairs in the stratosphere and troposphere. Regions of anticyclogenesis in the troposphere and stratosphere are more easterly than the conjugated regions of cyclogenesis. Circulation pairs in the troposphere are somewhat more easterly than regions having a minimal horizontal magnetic-field component. Attention is called to the long existence of a circulation pair in the stratosphere over Eastern Siberia which can be explained by proton absorption. Further direct measurements of these high-energy particles and correlation with barometric conditions would be highly desirable. (TTT)

16970 COMPUTATIONAL MODEL FOR SOLAR-FLARE-PARTICLE PROPAGATION. Englade, Ronald C. (Univ. of Chicago). J. Geophys. Res.; 76: 768-91(1 Feb 1971).

A realistic inclusive model for the post-acceleration propagation of solar-flare particles is presented that is suitable for numerical solution. The model assumes diffusion and energy loss in the solar atmosphere, gradual escape into the interplanetary medium, anisotropic energy-dependent diffusion in a stochastic interplanetary magnetic field whose average configuration is the Archimedian spiral pattern, convection and adiabatic deceleration produced by the solar wind, and an absorbing boundary for the particles at a finite heliocentric radius. By using parameter values that are supported by or at least do not contradict experimental data concerning the particle environment, sets of curves are obtained from detailed computer calculations. The predictions of the model are in qualitative accord with existing experimental observations of the intensity-versus-time behavior of solar-flare particles as a function of particle species, energy, flare longitude, and heliocentric radius of observation. Furthermore, the model is able to account reasonably well for observed features of the proton anisotropy-versus-time behavior as a function of energy and flare longitude. (auth)

16971 SOME RESULTS OF INVESTIGATIONS OF THE INHOMOGENEOUS STRUCTURE OF THE POLAR IONOSPHERE BY RECEPTION OF SATELLITE SIGNALS ON INTERFEROMETERS WITH DIFFERENT BASES. Alimov, V. A.; Getmantsev, G. G.; Erukhimov, L. M.; (and others) (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 21-4(1970).

Translated from Geomagn. Aeron.; 10: 28-53(1970).

The morphological characteristics of the amplitude fluctuations of signals at a frequency of 162 MHz are examined. The results of measurements of the spectrum of small-scale inhomogeneities responsible for these fluctuations in polar regions are reported. Data are presented on the magnitude of fluctuations of the electron component in the polar ionosphere. (auth)

16972 INSTABILITY ASSOCIATED WITH THE ANISOTROPY OF THE DISTRIBUTION FUNCTION OF ULTRARELATIVISTIC ELECTRONS IN THE RADIATION BELTS OF THE EARTH. Breizman, B. N.; Mirnov, V. V. Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 25-7(1970).

Translated from Geomagn. Aeron.; 10: 34-7(1970).

The cone instability of ultrarelativistic electrons in the radiation belts of the Earth is investigated. It is shown that relativistic effects significantly affect the characteristics of this instability. An example is given of a distribution function of ultrarelativistic electrons that is stable despite the presence of a loss cone. The results obtained explain the anomalously long lifetime of fast electrons in radiation belts observed experimentally. (auth)

16973 PASSAGE OF ELECTROMAGNETIC WAVES THROUGH WEAK INHOMOGENEITIES IN A PLASMA (IONOSPHERE). Berger, V. K.; Kim, V. F. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 28-33(1970).

Translated from Geomagn. Aeron.; 10: 38-45(1970).

The passage of a low-frequency electromagnetic wave through an inhomogeneous plasma layer with a high electron–molecule collision frequency is analyzed. The proposed solution is used to obtain appropriate expressions for reflection coefficients. The applicability of this solution to the ionosphere is discussed. (auth)

16974 INTERACTION OF PULSED RADIO WAVES IN THE IONOSPHERE. I. Vilenskii, I. M.; Izraileva, N. I. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 34-8(1970).

Translated from Geomagn. Aeron.; 10: 46-51(1970).

The interaction of vertically propagating pulsed radio waves in the ionosphere is analyzed in the framework of the elementary theory for the case of a disturbing wave of arbitrary power. (auth)

16975 GRADIENT OF THE ANNUAL VARIATION IN THE IONIZATION CHARACTERISTICS OF THE F2 LAYER. Likhachev, M. A. (Tomsk State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 39-41(1970).

Translated from Geomagn. Aeron.; 10: 52-5(1970).

The results are reported of a statistical analysis of observations by the global station network of the gradient of the annual variation of noon F2-layer ionization. It is found that the latitudinal distribution of this gradient differs depending on the solar activity level and the frequency range under consideration. (auth)

16976 TORSIONAL MAGNETOHYDRODYNAMIC VIBRATIONS IN THE EARTH'S CORE AND VARIATIONS IN DAY LENGTH. Braginskii, S. I. Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 1-8(1970).

Translated from Geomagn. Aeron.; 10: 3-12(1970).

It is shown that torsional magnetohydrodynamic vibrations may be responsible for variations in day length with a period of about 60 years and correlated variations in the westward drift velocity of the geomagnetic field. The amplitude of the vibrations of the region of the core near the equator is several times higher than that of its other regions. (auth)

16977 OUTFLOW REGIME OF A PLASMA FROM THE SUN. Konyukov, M. V. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 9-16(1970).

Translated from Geomagn. Aeron.; 10: 13-22(1970).

Permissible solutions of the equations of steady-state spherically symmetric outflow of a viscous and thermally conductive plasma from the Sun are investigated in a variable-temperature approximation. Analysis of the solutions and of observational data indicate the necessity of investigating plasma outflow from the Sun within the framework of a model with a finite radius of the region of frequency collisions. (auth)

16978 INVESTIGATION OF THE MOTION OF CHARGED PARTICLES IN A MODEL OF THE EARTH'S MAGNETOSPHERE. Kolomeets, E. V.; Mirkin, L. A. (Kazakh State Univ., Alma-Ata, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 107-8 (1970).

Translated from Geomagn. Aeron.; 10: 137-8(1970).

The design of a device for simulating the Earth's magnetosphere

is described to study the motion of charged particles in a disturbed magnetosphere. Account was taken of the fact that at least the magnetospheric day side is properly reproduced in the two-dipole model. Results of the plasma motion in the field of the quiet and disturbed dipoles are examined. (J.C.W.)

16979 ONE METHOD OF SOLVING THE PROBLEM OF ELECTROMAGNETIC WAVE PROPAGATION IN A THREE-DIMENSIONALLY INHOMOGENEOUS ISOTROPIC IONOSPHERE. **Egorov, I. V.; Kiyanovskii, M. P. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 109-10(1970).**

Translated from Geomagn. Aeron.; 10: 139-40(1970).

A method using geometrical optics is described for finding the phase, amplitude, and polarization of an electromagnetic wave propagating in a three-dimensionally inhomogeneous isotropic ionosphere. The main characteristics that describe wave propagation on a radio link are computed, such as the group path, the distance between transmitting and receiving stations, absorption along the ray in the ionosphere, the angles of arrival, and the MUF. (J.C.W.)

16980 SOME CHARACTERISTICS OF THE VARIATIONS OF ELECTRON CONCENTRATION IN THE EQUATORIAL IONOSPHERE DURING THE DAYTIME. **Goncharov, L. P.; Shchepkin, L. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 111-12(1970).**

Translated from Geomagn. Aeron.; 10: 141-3(1970).

Some characteristic features of the diurnal variation of electron concentration at fixed levels below the F2-layer maximum are examined on the basis of the N(h) profiles of the ionosphere obtained from observations on the schooner Zarya in Dec. 1962, Jan. 1963, and Nov. 1960 near the equator. During the daylight hours, the curves of the diurnal pattern of the N_h (S_N) change unusually with latitude and height. The daytime variations of N can be associated with drift-like movements of the electron-ion gas and diurnal temperature variations. Below 150 to 200 km, the daily variations of N are probably determined mainly by photochemical processes, as seen by the close relationship between electron concentration and the height of the Sun above the horizon. (J.C.W.)

16981 METHOD OF OBTAINING ON AN ELECTRONIC COMPUTER APPROXIMATING RELATIONSHIPS BETWEEN THE ROOT-MEAN-SQUARE DEVIATIONS OF CRITICAL F2-LAYER FREQUENCIES AND LATITUDE AND SOLAR ACTIVITY. **Gubenko, V. S.; Rodionov, Ya. S. Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 113-15(1970).**

Translated from Geomagn. Aeron.; 10: 144-6(1970).

Sample root-mean-square deviations are used that are more accurate estimates of the true standard deviations of f_0F2 than previous methods used. Monthly tables of hourly f_0F2 measurements were used to obtain approximating relationships from the 1948 to 1953 data at the Tixie Bay, Leningrad, Moscow, Sverdlovsk, Tomsk, Rostov-on-the-Don, Irkutsk, Alma-Ata-, and Ashkhabad stations. The sample root-mean-square deviations were computed from each monthly table for each hour of the day. The approximation is better for the summer than winter and autumn–spring months. (J.C.W.)

16982 DEPENDENCE OF THE POSITION OF THE MAXIMUM OF THE rn(r) FUNCTION ON VERTICAL IONIZATION PROFILE IN THE VALLEY AND ON OPERATING FREQUENCY. **Shlionskii, Sh. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 115-16(1970).**

Translated from Geomagn. Aeron.; 10: 147-8(1970).

The behavior of radio-wave paths under given initial emission conditions is determined by the spatial distribution of the rn(r) function (r is geocentric distance and n is the index of refraction). The upper and lower reversal points of paths of different shape are located on both sides of levels corresponding to the maxima of the rn(r) function. These levels play a guiding role during radio-wave propagation. The maxima and minima of the function rn(r) are examined. (J.C.W.)

16983 IONIZATION FUNCTION AT MINIMUM SOLAR ACTIVITY. **Velichanskii, V. N.; Ivel'skaya, M. K.; Klimov, N. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 118-19(1970).**

Translated from Geomagn. Aeron.; 10: 149-50(1970).

The ionization function of the thermosphere is computed on the basis of Jacchia's model, using the cross sections of ionization, absorption, and flux of ionizing radiation in various spectral intervals from works by Hinteregger, Hall, and Schmidke. The computations are made for the temperature range from 600 to 1300°K at 50°K intervals for zenith angles of the Sun from 10 to 110°. Values of the ionization function are obtained every 10 km at heights from 120 to 200 km and every 20 km at heights from 200 to 500 km. Tables are compiled for the ionization rates of the main components of the atmosphere (O, N_2, and O_2) in the given intervals of temperature, zenith angles, and heights. (J.C.W.)

16984 DIURNAL VARIATIONS OF THE EFFECTIVE RECOMBINATION COEFFICEINT IN THE IONOSPHERE E REGION AS A FUNCTION OF ELECTRON TEMPERATURE. **Korsunova, L. P. (Inst. of Applied Geophysics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 119-21(1970).**

Translated from Geomagn. Aeron.; 10: 151-3(1970).

Theoretical computations, using solar ultraviolet radiation as the heat source, show that thermodynamic equilibrium must exist in the E region ($T_e = T_i = T_n$). The results of measurements of the temperature of charged particles by the incoherent scatter method support these computations, but rocket experiments in 1960 to 1966 show that during the daytime $T_e \approx 2T_n$ at h = 110 to 130 km, in geomagnetically quiet periods. This difference increases during disturbances. Errors have not been found in the methods for computation of measuring electron temperature in the E region. The rocket data are examined for the diurnal variations of T_e in the E region. T_e measurements were selected that were made in years of low solar activity under quiet geomagnetic conditions and at mid-latitude. Results of measurements of neutral temperature at low solar activity are presented. (J.C.W.)

16985 CHARACTERISTICS OF THE EQUATORIAL ANOMALY OF F2 LAYER IONIZATION AT NOON DURING THE WINTER AND SUMMER SOLSTICES. **Besprozvannaya, A. S. (Arctic and Antarctic Scientific Research Inst., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 42-4(1970).**

Translated from Geomagn. Aeron.; 10: 56-8(1970).

The equatorial anomaly during the winter and summer solstices is estimated qualitatively. The computed values of critical F2-layer frequency are used as the reference level. It is shown that there are seasonal differences in the equatorial anomaly which are most distinct for the American zone. (auth)

16986 IONOSPHERIC EFFECT OF A LOW-ENERGY SOLAR PLASMA EMITTED DURING PROTON FLARES. **Goncharova, E. E.; Zevakina, R. A.; Lavrova, E. V.; Yudovich, L. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 51-4(1970).**

Translated from Geomagn. Aeron.; 10: 67-72(1970).

The change of the F region after several proton and nonproton flares is analyzed. It is demonstrated that ionospheric–magnetic disturbances have a smaller delay and a greater activity after proton than nonproton flares. The variation of the F region shows no characteristics associated with proton flares. (auth)

16987 INVESTIGATION OF THE RELATIONSHIP BETWEEN RIOMETER ABSORPTION AND IONOSPHERIC-MAGNETIC ACTIVITY IN THE AURORAL ZONE. **Gorshkov, Yu. N.; Denisenko, N. M. (Northeastern Complex Scientific Research Inst., Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 55-7(1970).**

Translated from Geomagn. Aeron.; 10: 73-6(1970).

The results are reported of a study of the dependence of diurnal and seasonal variations of cosmic radio-noise absorption in the auroral zone on the geomagnetic activity level and the state of the ionosphere. A relationship is found between absorption and the K index, between absorption and minimum reflection frequency, and none between absorption and critical F2-layer frequency. (auth)

16988 COMPARISON OF THE VARIABILITY OF AURORAL RADIO-WAVE ABSORPTION IN THE IONOSPHERE AT LOPARSKAYA AND COLLEGE. **Rapoport, Z. Ts. (Polar Geophysical Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 58-61(1970).**

Translated from Geomagn. Aeron.; 10: 77-83(1970).

The probability of auroral radio-wave absorption at a frequency of ~30 MHz in the ionosphere and the character of its variation at Loparskaya and College are compared. It is demonstrated that the diurnal variations of auroral absorption differ at the two points. (auth)

16989 POSSIBILITY OF DETERMINING THE REACTION RATE COEFFICIENTS FROM IONOSPHERIC DATA. **Krinberg, I. A.; Velichanskii, B. N.; Klimov, N. N.; Solov'ev, Yu. F. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 62-6(1970).**

Translated from Geomagn. Aeron.; 10: 84-9(1970).

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The equation of the balance of charged particles for the ionosphere is analyzed in a quasi-stationary approximation. It is demonstrated that as a consequence of the quasi-stationarity of the process of charge production and neutralization and of the presence of electron-concentration fluctuations, explicit determination of the reaction-rate coefficients from the curve of the diurnal electron-concentration pattern $n_e(t)$ at heights of 100 to 200 km requires introduction of additional relationships. (auth)

16990 INFLUENCE OF SPHERICITY ON THE DETERMINATION OF THE HORIZONTAL GRADIENTS OF IONOSPHERIC PARAMETERS FROM OBLIQUE SOUNDING DATA BY THE METHOD OF EQUIVALENT SLOPES. **Tushentsova, I. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 67-71(1970).**

Translated from Geomagn. Aeron.; 10: 90-6(1970).

Analytical expressions are obtained for the minimum equivalent path of a ray in a horizontally homogeneous ionosphere and an ionosphere with an equivalent angle of inclination α for a spherical model of the Earth and ionosphere. Experimental oblique-sounding data are used to compute the equivalent angles of inclination and these angles are compared with the same angles for a plane model and with angles obtained from vertical sounding. (auth)

16991 ZONE OF PULSATING AURORAS. **Roldugin, V. K.; Starkov, G. V. (Polar Geophysical Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 72-4(1970).**

Translated from Geomagn. Aeron.; 10: 97-100(1970).

Photometric observations at two stations, Loparskaya ($\Phi = 64.3°$) and Kem' ($\Phi = 60.6°$), are analyzed. It is demonstrated that pulsations appear mainly around midnight and in the morning, and the region covered by the pulsations widens mainly eastward as magnetic activity increases. The zone of pulsating auroras is located in the vicinity of the equatorial boundary of the oval zone. (auth)

16992 VERTICAL ELECTRIC FIELDS IN THE REGION OF THE HYDROGEN ARC. **Pivovarov, V. G. (Inst. of Cosmophysical Investigations and Aeronomy, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 75-9(1970).**

Translated from Geomagn. Aeron.; 10: 101-6(1970).

The passage of a proton flux through the atmosphere is examined using a one-dimensional model. Vertical electric fields are estimated, and the distribution of the space charge responsible for the vertical field is found. (auth)

16993 SOME CHARACTERISTICS OF THE POLARIZATION OF Pc1 PULSATIONS ASSOCIATED WITH THEIR WAVEGUIDE PROPAGATION. **Baranskii, L. N. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 86-9(1970).**

Translated from Geomagn. Aeron.; 10: 114-18(1970).

Some polarization patterns of Pc1 pulsations are analyzed and interpreted from the viewpoint of their propagation along an ionospheric waveguide centered on the F2-layer. (auth)

16994 METHOD OF COMPUTING THE GEOMAGNETIC FIELD UPWARD IN NEAR-EARTH SPACE. **Vints, B. D.; Pochtarev, V. I.; Rakhmatulin, R. Sh. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 90-8(1970).**

Translated from Geomagn. Aeron.; 10: 119-28(1970).

In addition to conversion errors in the construction of maps of the vertical distribution of the geomagnetic field in near-Earth space, there arises the problem of the influence of the accuracy of initial data, i.e., ground-based, marine, and aeromagnetic measurements, on that of the maps. Using the methods of the theory of random fields, it is shown that the influence of the initial material on the accuracy of vertical maps decreases significantly with height. (auth)

16995 DIRECTION OF THE IONOSPHERIC CURRENT IN THE POLAR REGION. **Mansurov, S. M.; Mansurova, L. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 121-3(1970).**

Translated from Geomagn. Aeron.; 10: 154-6(1970).

The regular diurnal magnetic-field variations at the surface of the Earth near the poles are known to resemble the magnetic field of the horizontal current that flows continuously in the ionosphere from the night to the day side. The direction of this current deflects to the west from the noon meridian. It has been shown that the intensity of this current is maximal around noon in local summer and minimal around midnight in local winter. Inversely, the angle α, formed by the direction of the current over a given point with the Earth–Sun line, is smallest at noon in local summer and greatest at midnight in local winter. In addition to seasonal and diurnal variations in LT, the angle α also experiences diurnal variations in UT, variations in the 11-year cycle, and also nonseasonal annual variations. The possibility of a relationship between the direction of the ionospheric current, equivalent to diurnal geomagnetic variations in the polar region, and the direction of the interplanetary magnetic field follows from the cyclic variations of α. Using the known relationship between solar-wind velocity and the direction of the streamlines at the orbit of the Earth, the direction can be determined from the average diurnal solar-wind velocity values. (J.C.W.)

16996 POSSIBILITY OF INVESTIGATING THE FINE STRUCTURE OF THE IONOSPHERE FROM SIGNAL BROADENING ON IONOGRAMS. **Perelygin, V. P. (Tomsk State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 125-6(1970).**

Translated from Geomagn. Aeron.; 10: 158-9(1970).

A method of investigating the fine structure of the ionosphere from signal broadening was developed. The method was applied directly on ionograms. When an ionogram is recorded at ionospheric stations, the main equipment constant is the recording level, α. It is necessary to determine the real recording level α to determine the parameters of the region of radio-wave scattering. An algorithm for computing the parameters of the scattering region was constructed. Ionograms obtained at the Tomsk ionospheric station every 15 minutes, from Aug. 8 to 14, 1966, were analyzed. (J.C.W.)

16997 GEOMAGNETIC ACTIVITY, E_s FORMATIONS, AND IONOSPHERIC RADIO-WAVE ABSORPTION. **Zherebtsov, G. A.; Kurilov, V. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 127-8(1970).**

Translated from Geomagn. Aeron.; 10: 160-1(1970).

The relationship between the appearance of an E_s layer and geomagnetic activity is discussed. Data from 7 stations were analyzed statistically for the 1965 ionospheric soundings. The location of the stations made it possible to determine the latitudinal pattern of the dependence of E_s occurrence with $f_0E_s \geq 5$ MHz on the K_p index. Days with enhanced geomagnetic activity for which $\Sigma K_p \geq 18$ and magnetically relatively quiet days with $\Sigma K_p \geq 9$ were selected for analysis. The diurnal distribution of the probability of $f_0E_s \geq 5$ MHz for magnetically quiet and disturbed days was constructed. Radio-wave absorption is usually observed at high latitudes during aurorae and in the morning after aurorae. Total absorption is also observed during magnetically quiet periods, particularly at the polar-cap stations. When the magnetic field is undisturbed, the probability of absorption in the zone of maximum auroral frequency is insignificant and in the morning hours it reaches 10 to 15% against 30 to 40% in magnetically disturbed periods. (J.C.W.)

16998 RING CURRENT AND AURORAL OVAL IN THE MORNING AND EVENING. **Starkov, G. V.; Fel'dshtein, Ya. I. (Polar Geophysical Inst., Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 129-30(1970).**

Translated from Geomagn. Aeron.; 10: 162-3(1970).

The position of the auroral oval is associated with the intensity of magnetic disturbance. The intensities of polar disturbances and the magnetospheric ring current increase during magnetic storms. The position is compared with previous results for day and night data. Data obtained previously can be reduced for the position of the boundaries of the auroral oval to the intensity of the ring current. The influence of the ring current on the position of the oval is manifest mainly in the shift of the entire region toward the equator and in its broadening in the noon, midnight, and postmidnight hours. (J.C.W.)

16999 VARIABILITY OF Sq VARIATIONS AT MAGNETICALLY CONJUGATE AND SUBFOCAL OBSERVATORIES. **Chikovani, Dzh. S. (Inst. of Geophysics, Tbilisi, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 132-3(1970).**

Translated from Geomagn. Aeron.; 10: 166-7(1970).

The geographic and corrected geomagnetic coordinates of two pairs of magnetically conjugate observatories, Logrono–Hermanus and San Juan–Trelew, at the near-focal latitudes of Sq currents are tabulated. The interrelationship of the foci of the Sq system of subfocal observatories was investigated and it was determined that they move simultaneously in one direction (north or south) in the European–African sector (33%); the American sector (39%); and the Asian–Australian sector (47%). In other cases, they behave independently of one another. It can be concluded that in years of high solar activity the Sq variations are not magnetically conjugate in the northern and southern hemispheres of the European–African and American sectors and that the day-to-day positions of the foci of the Sq system generally vary independently of each other in both hemispheres. (J.C.W.)

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17000 SEASONAL DEPENDENCE OF PREFERRED DIRECTION OF POLARIZATION OF GEOMAGNETIC VARIATIONS. Dubrovskii, V. G.; Solokhov, V. V. (Inst. of the Physics of the Earth and Atmosphere, Ashkhabad, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 134-5(1970).

Translated from Geomagn. Aeron.; 10: 167-8(1970).

Extensive data on the morphology of geomagnetic variations, observed in a broad frequency range at the surface of the Earth, indicate that the preferred direction of their polarization (preferred orientation of the vectograms of pulsations or the direction of the major axes of statistical polarization ellipses) depends on their excitation mechanism, and the geographical location and geological structure of the observation area. Previous data refer to the diurnal patterns of the preferred direction of polarization of geomagnetic pulsations and to variations in the direction of rotation of the vectors of variations. The new data indicate the existence of a definite pattern in the seasonal variation. The study was made on the basis of an analysis of the magnetotelluric field observational results in the West Turkmen lowland along the Chikishlyar–Sharlouk profile. Analysis showed that along the entire profile the major axes of magnetic and electric statistical polarization ellipses are orthogonal within 10 to 15° for the range of periods 10 to 200 sec. The sharp seasonal changes in the preferred direction of polarization of magnetic micropulsations cannot be explained by the geological structure of the region observed and thus be directly or indirectly associated with the excitation mechanism of short-period pulsations of the electromagnetic field of the Earth. (J.C.W.)

17001 KELVIN INSTABILITY IN A COMPOSITE HYDROMAGNETIC SYSTEM. Talwar, S. P. (Langley Research Center, Hampton, Va.). Cosmic Electrodyn.; 1: 255-68(Dec 1970).

The instability resulting from a tangential discontinuity in velocities in a composite (two-component) hydromagnetic system is investigated, using the normal mode analysis. The two components are hydromagnetically coupled through the ambient magnetic field. Criteria of instability are derived, taking the magnetic field aligned or transverse to flow in each half-space and for an orthogonal field geometry. The results are discussed in relation to the observed discontinuities in the solar wind. Further, it is found that a two-stream instability arises in a composite system (devoid of any tangential discontinuity) consisting of two interpenetrating infinitely conducting streams for interpenetration speeds exceeding the Alfvén speed $H_0\sqrt{(\rho_1+\rho_2)/(4\pi\rho_1\rho_2)}$. (auth)

17002 PLASMA WAVES IN SPACE AND IN THE LABORATORY. VOLUME 2. Proceedings of NATO Advanced Study Institute, Roeros, Norway, 17–26 April 1968. Thomas, J. O.; Landmark, B. J. (eds.). New York; American Elsevier Publishing Company, Inc. (1970). 570p. $21.00. (In English and French). (CONF-680455-(Vol.2)).

Twenty-seven abstracts of separate papers are included. (M.O.W.)

For abstracts of individual papers see: 17003–17020, 17143, 17161, 17182, and 17238–17243.

17003 ANALYSIS OF ALOUETTE I PLASMA RESONANCE OBSERVATIONS. Benson, R. F. (Goddard Space Flight Center, Greenbelt, Md.). pp 27-54 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

Results are presented from an analysis of the Alouette I plasma resonances, conducted to obtain information on the physical nature of the observed phenomena. The interaction volume associated with the observed resonances is discussed in particular. The relation of the observed cyclotron harmonic frequency f_n and the harmonic law $f_n = nf_H$ is discussed also. (M.O.W.)

17004 STIMULATION OF IONOSPHERIC-RESONANCE ECHOES BY THE ALOUETTE II SATELLITE. Muldrew, D. B.; Hagg, E. L. (Defence Research Telecommunications Establishment, Ottawa). pp 55-68 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

Observations are described of delayed echoes radiated from the topside ionospheric plasma following excitation by a sequence of pulses at frequencies between f_H and the electron plasma frequency f_N. The generation of these echoes is thought to be similar to the generation of cyclotron echoes. Hence the ionospheric delayed echoes are referred to as ionospheric resonance echoes. (M.O.W.)

17005 NOVEL SPIKE OBSERVED ON ALOUETTE II IONOGRAMS. Hagg, E. L.; Muldrew, D. B. (Defence Research Telecommunications Establishment, Ottawa). pp 69-75 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

A resonance spike observed on Alouette II ionograms, when the operating frequency $f = f_T/2 = f_N - f_H$, is discussed. The following hypothesis for the production of the spike is given: (1) the second harmonic output of the sounder energizes the f_T resonance, (2) energy in the f_T resonance couples into the f_N and f_H resonances, (3) the f_N and f_H resonances interact and produce a propagating electrostatic wave of frequency $f_N - f_H$, and (4) the electrostatic wave is detected by the receiver and recorded as a floating spike. (M.O.W.)

17006 ELECTRON DENSITY MEASUREMENTS IN THE IONOSPHERE WITH HIGH-ALTITUDE ROCKETS. Meizner, F.; Rabben, H. H. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). pp 77-87 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

A brief discussion of the theory of an rf impedance probe in a homogeneous plasma is given. Electron density measurements above Kiruna, Sweden are given. (M.O.W.)

17007 ALOUETTE PLASMA RESONANCE PHENOMENA. Tataronis, J. A.; Crawford, F. W. (Stanford Univ., Calif.). pp 91-109 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

Magnetoplasma resonance phenomena occurring perpendicular to the magnetic field were studied theoretically in order to determine the relative strengths of the resonances and to determine which are to be expected experimentally. A one-dimensional, quasi-static theory is presented. A numerical study was made of the relative strengths of the electric fields at the various resonances for the case of excitation by a planar dipole sheet, and of the current and voltage response for excitation by a pair of permeable planar grids. (M.O.W.)

17008 HIGHER-ORDER CYCLOTRON HARMONIC RESONANCES AND THEIR OBSERVATION IN THE LABORATORY AND IN THE IONOSPHERE. Shkarofsky, I. P. (RCA Victor Research Labs., Montreal). pp 111-21 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

The problem is visualized as a plot of angular frequency ω versus perpendicular wave number $k_\perp$, with $k_\parallel$ assumed practically zero. The order of the harmonic is n and ω_b is the angular cyclotron frequency. An analysis was made of the electrostatic mode as $k_\perp$ decreases. The electromagnetic dispersion curve was studied as it passes through the $n\omega_b$ frequencies. (M.O.W.)

17009 INTERPRETATION OF TOPSIDE RESONANCES AS OBLIQUE ECHOES. McAfee, J. R. (ESSA Labs., Boulder, Colo.). pp 123-8 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

The behavior of the dispersion relation is illustrated for a given operating frequency, electron-gyrofrequency, and temperature T, and for four values of the plasma frequency. The index of refraction increases dramatically at a given angle which corresponds to the cold plasma resonance angle. Rotation about $\theta = 0$ produces a refractive index surface characterized by a nose instead of the cold plasma resonance cone. The behavior of the resulting group velocity is shown. The results suggest that a topside sounder would receive an echo trace rather than a resonance. (M.O.W.)

17010 DETECTION OF THE UPPER HYBRID RESONANCE BY SATELLITES. Shkarofsky, I. P. (RCA Victor Research Labs., Montreal). pp 159-67 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

A theory is given that includes electromagnetic plus electro-

static contributions and accounts for satellite motion. It illustrates the decrease in ringing time at ω_p^2/ω_b^2 values equal and somewhat greater than 3. It predicts a strong response for larger ω_p^2/ω_b^2 values. The beating phenomena can possibly be accounted for. (M.O.W.)

17011 ASYMPTOTIC TIME BEHAVIOUR OF PLASMA RESONANCES. Watson, S. R. (Cambridge Univ., Eng.). pp 169-81 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

The resonances experienced by an infinitesimal dipole moving through a hot uniform electron plasma in a uniform magnetic field are studied. It was assumed that there is no plasma sheath, and that the electrostatic approximation is valid. The nature of the integrals involved in evaluating the electric field due to a dipole was studied. Resonances due to Bernstein modes are then discussed. (M.O.W.)

17012 NUMERICAL INVESTIGATION OF ELECTROSTATIC WAVES AT MEGAHERTZ FREQUENCIES IN THE UPPER IONOSPHERE. Hultqvist, B. (Kiruna Geophysical Observatory, Sweden). pp 199-232 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

Numerical investigations are reported of electrostatic oscillations at megahertz frequencies in a collisionless warm plasma, approximately corresponding to the exosphere at about 1000-km height. (M.O.W.)

17013 OBSERVATIONS OF NATURALLY OCCURRING VLF AND MAN-MADE HF PLASMA WAVES IN AURORAL REGIONS OF THE IONOSPHERE. Joergensen, T. S. (Danish Meteorological Inst., Charlottenlund); Bell, F. T. pp 377-87 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

The results are discussed of a study of vlf and topside sounder data acquired on the OGO 2 and Explorer 20 satellites as they traversed the auroral zone. Electron density irregularities and the vlf hiss measurements are discussed in particular. (M.O.W.)

17014 OBSERVATIONS OF VLF EMISSIONS ALONG A N-S CHAIN OF STATIONS CROSSING THE AURORAL ZONE. Harang, L. (Norwegian Defence Research Establishment, Kjeller). pp 381-97 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

An analysis of the appearance of vlf emissions along the chain is given. The recordings indicate that two types of vlf emissions appear, auroral (or polar) emissions along and close to the auroral zone occurring only at night time and by preference during the winter months, and a low-altitude type having a different character and occurring during day time. (M.O.W.)

17015 RECENT ROCKET MEASUREMENTS OF AC ELECTRIC AND MAGNETIC FIELDS IN THE IONOSPHERE. Shawhan, S. D. (Royal Inst. of Tech., Stockholm); Gurnett, D. A. pp 399-409 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

A rocket experiment was conducted to determine the amplitude and frequency spectra of naturally occurring electric and magnetic fields in the frequency range of 3 Hz to 10 kHz (vlf) and to ascertain the performance of different types of electric-dipole antennas. The data are described. (M.O.W.)

17016 RESPONSE OF A DOUBLE-SPHERE DIPOLE ANTENNA TO VLF ELECTROSTATIC PLASMA WAVES. Fiala, V.; Storey, L. R. O. (CNRS-GRI, Saint-Maur-des-Fosses, France). pp 411-26 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

The response of the probe to ion sound waves propagating directly along the magnetic field and to drift waves propagating directly across the magnetic field is studied. The performance of the antenna is considered under a wide variety of conditions. (M.O.W.)

17017 DETERMINATION OF IONIC TEMPERATURE FROM PROPAGATION TIME OF PROTON WHISTLERS. Quemada, D.; Velut, P. M.; Vigneron, J. (Paris Univ., Orsay, France). pp 427-9 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

Whistler sonagrams recorded on satellites Injun III and Alouette I are discussed. A technique for determining the ion temperature from the proton whistler curves is described. (M.O.W.)

17018 TRAPPED PARTICLES. Laird, M. J. (King's Coll., London). pp 433-7 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

A brief theory for the motion of a charged particle in an oscillating electric field is given. It is then shown that a comparable phenomenon can occur when a transverse electromagnetic wave propagates with phase velocity parallel to a uniform magnetic field. (M.O.W.)

17019 THEORY OF THE EFFECT OF COLLISIONS ON ION-CYCLOTRON WHISTLERS. Jones, D. (Cavendish Lab., Cambridge, Eng.). pp 471-85 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

Models of the ionosphere are discussed. The effect of collisions is examined in some detail. (M.O.W.)

17020 LOW-FREQUENCY DRIFT OSCILLATIONS IN THE MAGNETOSPHERE. Coroniti, F. V.; Kennel, C. F. (Univ. of California, Berkeley). pp 535-48 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

The following two instabilities in a magnetospheric plasma are investigated: (1) the finite Larmor radius interchange wave that is nonresonantly unstable to the total pressure gradient on the outer edge of the ring-current belt, and (2) a drift-wave instability that is resonantly unstable to electron temperature and density gradients on the inner boundary of the plasma sheet. (M.O.W.)

17021 MAGNETIC EFFECT OF INTERACTION OF MAGNETOSPHERE WITH FILAMENT-LIKE INHOMOGENEITY OF THE SOLAR WIND. Mikerina, N. V.; Ivanov, K. G. Cosmic Res. (USSR) (Engl. Transl.); 8: 137-9(Jan-Feb 1970).

Translated from Kosm. Issled.; 8: 149-51(Jan-Feb 1970).

A simultaneous consideration of specific phenomena of the solar wind together with the corresponding earth-surface geomagnetic disturbance and of the processes in the magnetosphere are of considerable importance in the study of mechanisms of magnetosphere storms. This was done earlier, in particular, for strong discontinuities in the solar wind: tangential and fast shockwave. In work reported here, the magnetic effect was investigated of a filament-like inhomogeneity of the solar wind reaching the magnetosphere and observed by the space rocket "Pioneer-6" on January 20, 1966. It was noted earlier that this inhomogeneity represents a region of a relatively cold and dense plasma, presumably bounded by two strong discontinuities from the hotter and rarified plasma of the solar wind. It was only possible to approximately identify these discontinuities on the basis of qualitative considerations. (auth)

17022 EXPERIMENTAL DEMONSTRATION OF THE EXISTENCE OF A HYDROGEN-ION FLUX IN THE EXOSPHERE. Yaichnikov, A. P. Cosmic Res. (USSR) (Engl. Transl.); 8: 140-2(Jan-Feb 1970).

Translated from Kosm. Issled.; 8: 151-3(Jan-Feb 1970).

Measurements of proton fluxes taken by Elektron 2 and Elektron 4 satellites during a period of minimum solar activity are presented. Spectral distributions are shown. (M.O.W.)

17023 INVESTIGATION OF GEOACTIVE CORPUSCLES AND PHOTOELECTRONS ON THE KOSMOS-261 SATELLITE. I. Bolyunova, A. D.; Bragin, M. L.; Gal'perin, Yu. I.; (and others). Cosmic Res. (USSR) (Engl. Transl.); 8: 96-9(Jan-Feb 1970).

XUM

Translated from Kosm. Issled.; 8: 104-7(Jan-Feb 1970).

A highly varied experiment was conducted for investigating low-energy geoactive corpuscles and virgin photoelectrons and their interaction with the Earth's upper atmosphere. This experiment included coordinated measurements of geoactive corpuscles from the "Kosmos-261" satellite and observations of a variety of geophysical phenomena associated with them in a broad network of ground geophysical observatories in the USSR and other socialist countries. (auth)

17024 INVESTIGATION OF GEOACTIVE CORPUSCLES AND PHOTOELECTRONS ON THE KOSMOS-261 SATELLITE. II. Gal'perin, Yu. I.; Dzhordzhio, N. V.; Ivanov, I. D.; (and others). Cosmic Res. (USSR) (Engl. Transl.); 8: 100-9(Jan-Feb 1970).

Translated from Kosm. Issled.; 8: 108-19(Jan-Feb 1970).

A low-energy spectrometer operating in the energy range 30 eV to 15 keV is described. The electrons undergo energy selection in a cylindrical capacitor and are registered by a scintillation counter with two photomultipliers operating in a coincidence circuit. The instrument field of view is circular, aperture angle is ±3.5°, geometry factor is 2×10^{-3} cm^2 · sr, energy resolution $\Delta E/E = 0.19$. In the first range (30 to 150 eV) energy scanning is done smoothly using a sawtoothed voltage; in the second range, scanning is done successively for three fixed energies 1, 4.5, and 15 keV. The instrument can be switched from one regime to another by command from the earth. This paper gives the first results of measurements on the "Kosmos-261" satellite. The equilibrium energy spectrum of virgin photoelectrons was measured at different latitudes for different pitch angles. Some auroral electrons with energies from 30 eV to approximately 1 keV were registered both in the "second" auroral zone and in the main auroral zone, where electrons with energies of 4.5 and 15 keV were also very intensive even during magnetically quiet periods. A structureless "background" of electrons with an almost constant intensity and a slowly changing angular distribution was observed on many orbits passing approximately along the auroral oval during transit from the midnight to morning sectors. The energy flux of these electrons is approximately 1 erg/cm^2 · sec. Near the midnight sector, and with transit from the midnight to evening sectors, the fluxes of auroral electrons are far more irregular, with clearly expressed peaks, particularly in the 4.5-keV range. In the middle and low latitudes no measurable electron intensities could be detected in the keV range. The upper limit of the energy flux in the quiet atmosphere is approximately $<1.5 \times 10^{-2}$ erg/cm^2 · sec. An exception is the equatorial ionospheric anomaly region where, as before (on the "Kosmos-5" satellite), soft electrons were sporadically registered. (auth)

17025 INVESTIGATION OF GEOACTIVE CORPUSCLES AND PHOTOELECTRONS ON THE KOSMOS-261 SATELLITE. III. Gal'perin, Yu. I.; Gladyshev, V. A.; Ivanov, I. D.; (and others). Cosmic Res. (USSR) (Engl. Transl.); 8: 110-15(Jan-Feb 1970).

Translated from Kosm. Issled.; 8: 120-6(Jan-Feb 1970).

The RIP-801 low-energy ion spectrometer is described. It was used on the "Kosmos-261" satellite for measuring ions in the range 0.04 to 8 keV. It is a modulation trap with magnetic shielding of the ring collector which suppresses the currents of secondary electrons and photoelectrons from the collector. The ion flux is modulated by a voltage in the form of a square wave with a frequency of 300 cps and voltage amplitude of 0.5 and 2 kV above threshold voltages from 0.04 to 6 kV. The current of the central collector and the positive current of the ring collector are measured. The paper gives the first results of measurements on the "Kosmos-261" satellite. Fluxes of ions with energies of several keV, attaining 10^7 ions · cm^{-2} · sec^{-1} · keV^{-1}, were registered in regions close to the auroral zones. After midnight these particles are found in the northern hemisphere along the southern boundary of the electron injection region in the form of a "hydrogen arc." In addition, in the south and north polar caps in the region of invariant latitudes 70 to 80°, ions were registered simultaneously with soft electron in the so-called "second" or "soft" auroral zone. The energy spectra for ions in the northern hemisphere (nighttime, altitude about 220 km) and in the southern hemisphere (daytime, altitude about 600 km) are different. In the northern auroral zone the spectrum has a sharp peak in the region 1.5 to 2 keV, whereas in the southern auroral zone and south polar cap the spectrum is rather flat in the region 0.04 to 8 keV (without allowance for the proton charge-exchange effect during atmospheric penetration). The pitch-angle distribution usually has a maximum at about 70°. An example of an ion intensity burst in the low altitudes over the USSR at $L \approx 2$ is described. (auth)

17026 INVESTIGATION OF GEOACTIVE CORPUSCLES AND PHOTOELECTRONS ON THE KOSMOS-261 SATELLITE. IV. Bolyunova, A. D.; Verevkin, A. D.; Gal'perin, Yu. I.; (and others). Cosmic Res. (USSR) (Engl. Transl.); 8: 116-23(Jan-Feb 1970).

Translated from Kosm. Issled.; 8: 126-35(Jan-Feb 1970).

The RIÉ medium-energy electron scintillation spectrometer, RIP-802 proton scintillation spectrometer and RIG-111 lead-shielded Geiger counter are described. The RIÉ-205 instrument measured electrons in the ranges 20 to 45, 45 to 85, 85 to 120, and 120 to 150 keV and the total intensity of electrons with energies greater than 150 keV (geometry factor 2×10^{-3} cm^2 · sr). The RIP instrument measured protons in the ranges 0.30 to 0.45, 0.45 to 0.70, 0.70 to 0.95, and 0.95 MeV with a geometry factor 1.5×10^{-2} cm^2 · sr. The RIG-111 instrument measured protons with E > 50 MeV and hard electrons. In the radiation belts and auroral zones the fluxes and energy spectra of electrons and protons, their pitch-angle distribution and spatial-temporal characteristics were measured. It was possible to determine the latitude variation of intensity of injected electrons, pitch-angle distribution of electron density in the auroral zone and differential electron spectra. (auth)

17027 IONOSPHERIC SPREAD-F, SUNSPOT ACTIVITY, AND GEOMAGNETIC ACTIVITY. Bowman, G. G. (Queensland Univ., Brisbane). Nature (London). Phys. Sci.; 229: 117-18 (25 Jan 1971).

Possible associations between variations of less than two months in the occurrence of midlatitude spread-F and similar variations in both sunspot and geomagnetic activity were investigated. The results of the analysis suggest that at least some spread-F occurrence is intimately connected with some type of solar activity that is more active in regions away from sunspots. If some constituent of the solar wind is responsible, then it takes the particles about three days to arrive in the vicinity of the Earth, producing on arrival both spread-F activity and geomagnetic activity. There is also a sharp increase in geomagnetic activity about the same time as the relevant solar events, which are imagined as occurring away from sunspot regions. It is possible that this particular geomagnetic activity is associated with fast solar particles, which take a few hours to travel to the Earth after the solar events. (UK)

17028 ALFVEN IRREGULARITIES NEAR THE PLASMAPAUSE AND THEIR SIGNIFICANCE IN GEOMAGNETIC MICROPULSATIONS. Kikuchi, H. (National Academy of Sciences, Washington, D. C.). Nature (London). Phys. Sci.; 229: 79-80 (18 Jan 1971).

An Alfven anomaly with fine-structure irregularities is reported at and near the plasmapause and the significance of the irregularities in geomagnetic micropulsations is demonstrated by showing typical Alfvén-index profiles obtained from nearly simultaneous OGO-3 and Pc1 measurements. Emphasis is placed on a close correlation between fluctuating plasma distributions observed on the satellite and Pc1 micropulsations observed on the ground. This may be explained in terms of irregularities of the Alfvén index or velocity. (auth) (UK)

17029 PROPAGATION OF VERY-LOW-FREQUENCY RADIO WAVES IN DUCTS IN THE MAGNETOSPHERE. Walker, A. D. M. (Cambridge Univ., Eng.). Proc. Roy. Soc. (London). Ser. A: 321: 69-93(19 Jan 1971).

A method is developed to calculate waveguide modes in a plane-stratified duct of enhanced or reduced ionization density in an otherwise uniform magneto-ionic medium. It may, in principle, be applied to ducts with an arbitrary electron-density profile, and with dimensions of the order of the wavelength in the medium. Computations are carried out for one simple model with enhanced ionization density and parameters typical of whistler propagation. The fields inside and outside the duct are discussed. It is shown that the energy flux in the inhomogeneous wave outside the physical boundaries of the duct may in certain circumstances be important. The types of waveguide mode that may occur are discussed. In particular, there is one mode called the zero-order mode that always propagates even when the duct is very narrow or when the electron density in the duct differs only infinitesimally from that in the uniform medium outside. In the limit where the duct no longer exists, this mode becomes a plane wave. When the axis of the duct is curved and there are transverse gradients of ionization density and of magnetic field in the medium outside the duct, all modes may tunnel through a barrier region, in which the wave is evanescent, to a region where the energy is refracted away from the duct. Consideration of this process leads to a criterion for deciding whether a duct is sufficiently strong to maintain guiding. (auth) (UK)

17030 PRELIMINARY REPORT ON BALLOON OBSERVATION OF AURORAL X RAYS AT SYOWA STATION, ANTARCTICA. Ogura, Koichi (Nihon Univ., Chiba, Japan); Hayashi, Kanji; Roach, Gerard; Suda, Tomoshige; Kodama, Masahiro. Nankyoku Shiryo; No. 35, 35-6(1969).

From Collected Papers of the Institute of Physical and Chemical Research, Tokyo, 22-3(1969).

XUM

A series of balloon flights for measurements of auroral x-rays were performed at Syowa Station, Antarctica, from Jan. 14 to Feb. 14, 1969. A four-channel NaI-crystal instrument was lifted aloft in a plastic balloon. Results of 10 flights are summarized. (TSS) (auth)

17031 BALLOONBORNE INSTRUMENT FOR AURORAL X-RAY MEASUREMENTS. Kodama, Masahiro; Ogura, Koichi. Rikagaku Kenkyusho Hokoku; 45: 25-33(1969). (In Japanese).

From Collected Papers of the Institute of Physical and Chemi cal Research, Tokyo, 24-32(1969).

A balloon-borne instrument was developed for measuring auroral x rays over Syowa Station, Antarctica. Details of the instrument are given along with results of experimental investigation. Some discussion about further improvement is given, based on the balloon observations actually made at Syowa Station in January 1969. (auth)

17032 MEASUREMENT OF THE INTENSITY OF LOW-ENERGY PROTONS IN THE UPPER ATMOSPHERE. Tulinov, V. F.; Lipovetskii, V. A. Cosmic Res. (USSR) (Engl. Transl.); 8: 279-80(Mar-Apr 1970).

Translated from Kosm. Issled.; 8: 306-7(Mar-Apr 1970).

Two semiconductor detectors of protons in the energy range 1 to 20 MeV were mounted on an M-100 meteorological rocket launched in June, 1969 in midlatitudes. Soft, corpuscular radiation is present along with cosmic rays at middle-latitude heights of ~70 to 75 km. If protons are a component of the corpuscular radiation, the energy must be in the order of several MeV for them to penetrate into the atmosphere at 70 to 90 km. Information is limited for the energy spectra of the albedo of the cosmic rays composed of electrons and protons. An analysis of the results is examined for the flux of albedo protons in the region of low energies and the existing results of measurements of the energy spectrum of albedo protons for the region of high energies. It was shown that no protons are evidently present in the flux of soft, corpuscular radiation in the upper atmosphere, and some inadequate data were obtained for the energy spectrum of the protons of the albedo of cosmic rays in the region of low energies. (J.C.W.)

17033 COMPARISON OF MEASUREMENTS OF THE INTERPLANETARY MAGNETIC FIELD FROM THE SPACE STATIONS VENERA-4 and MARINER-5. Dolginov, Sh. Sh.; Eroshenko, E. G.; Zhuzgov, L. N. Cosmic Res. (USSR) (Engl. Transl.); 8: 265-71(Mar-Apr 1970).

Translated from Kosm. Issled.; 8: 290-7(Mar-Apr 1970).

Measurements of the field made by two simultaneously operating spacecraft (Venera-4 and Mariner-5) on the flight path from Earth to Venus are compared. The conclusion that the intensity of the interplanetary field is correlated with the level of magnetic activity on Earth and with the 27-day recurrence of solar activity is confirmed. (auth)

17034 FEASIBILITY OF USING RESONANCE-SCATTERING EFFECTS TO INVESTIGATE THE COMPOSITION OF THE UPPER ATMOSPHERE. Shvidkovskii, E. G.; Kostko, O. K.; Chayanova, E. A. Cosmic Res. (USSR) (Engl. Transl.); 8: 284-6 (Mar-Apr 1970).

Translated from Kosm. Issled.; 8: 310-11(Mar-Apr 1970).

The propagation of laser radiation through the atmosphere produces resonance scattering, and the resonance backscattering affords a useful tool for investigating the fine structure of the composition of the atmosphere. A detailed calculation of the resonance-scattering cross sections for one molecule of nitrogen has been performed. Metastable nitrogen molecules and ions which cause resonance scattering of the radiation from a neodymium laser, enter as constituents into the fine structure of the composition of the D and E layers of the ionosphere, and play a decisive role in the structure of the lower ionosphere ranging from 10 to 60 km. (J.C.W.)

17035 DEPENDENCE OF INTENSITY OF CORPUSCULAR RADIATION IN THE UPPER ATMOSPHERE ON SOLAR ACTIVITY. Tulinov, V. F.; Moisee, Yu. N.; Shapiro, I. G.; Ulanova, L. A. Cosmic Res. (USSR) (Engl. Transl.); 8: 281-3(Mar-Apr 1970).

Translated from Kosm. Issled.; 8: 307-9(Mar-Apr 1970).

A series of rocket measurements of the intensity of corpuscular radiation in the upper atmosphere was made from April 16 to 23, 1969, in middle latitudes. A great increase in corpuscular-radiation fluxes had been observed when a rocket was launched during strong geomagnetic perturbations in 1968. The effect of solar and geomagnetic activity on the intensity of the corpuscular radiation and on its variations is examined. The curve of absorption of soft, corpuscular radiation in the period of increased solar and geomagnetic activity is compared with that of the corresponding curve obtained from the previous measurements made under quiet conditions. It is concluded that although a marked increase in the intensity of corpuscular radiation is observed during the period of increased solar activity occurring in April, 1969, no direct connection can be found between the increase or decrease in intensity of the corpuscular fluxes in the upper atmosphere (except on Apr. 21) and particular solar flares. Also no direct connection is evident between changes in the K-index and individual solar flares, although the general level of perturbation of the geomagnetic field was fairly high in this period. (J.C.W.)

17036 ION DENSITIES IN THE NIGHT IONOSPHERE. Howard, Russell Alfred. College Park, Md.; Univ. of Maryland (1970). 164p. University Microfilms Order No. 70-22,555.

Thesis.

The nighttime-concentration profiles of the major ions in the ionosphere between 120 and 450 km were calculated from the known daytime concentrations. Agreement between the observed and calculated nighttime profiles of the O^+, NO^+, and O_2^+ ions is quite good if one allows normal Chapman–Enskog diffusion as well as chemical reactions to occur. By preserving electrical neutrality, good agreement is also obtained between the observed and calculated electron calculations. The concentration profiles were found to be highly sensitive to the values of the reaction-rate coefficients. (Diss. Abstr. Int., B)

17037 MODE THEORY OF THE WHISPERING-GALLERY GUIDANCE IN THE IONOSPHERE AT HF AND VHF FREQUENCIES. Chang, Hsi-tien. San Diego, Calif.; Univ. of California (1970). 134p. University Microfilms Order No. 70-23,043.

Thesis.

At frequencies above the maximum usable frequency for ground-to-ground ionospheric communication, propagation is possible between terminals located in the ionosphere. This phenomenon has been studied in the past using the ray theory and is treated in this work using the mode theory. At a given hf frequency there are a number of modes that are well-trapped and a number that leak profusely to the topside of the ionosphere. As the frequency is increased the number of well-trapped modes decreases. Ultimately, only one mode is reasonably well-trapped and leakage even of this mode sets in. It is the frequency at which this happens that determines the maximum usable frequency of the ionosphere for whispering-gallery propagation. With the use of a Chapman model of ionospheric density, the maximum usable frequency for whispering-gallery propagation is found to be about six times the peak plasma frequency for the F region and about fifteen times that for the E region. The larger ratio for the E region is associated with a smaller scale height. A discontinuous plasma layer would give an even higher ratio of the maximum usable frequency of the whispering-gallery mode to the peak plasma frequency. For the E-region whispering gallery, however, the effect of collision is found to cause serious attenuation of trapped modes even at frequencies close to the maximum usable frequency. It is the whispering-gallery associated with the F region that has practical value and can be used to explain the results of various satellite experiments. Scattering by irregularities in the duct is also considered. The scattered field depends not only on the correlation function of the irregularities but also on the height-gain functions of the individual modes. (TSS) (Diss. Abstr. Int., B)

17038 DYNAMICS OF THE OUTER MAGNETOSPHERE. Hung, Ru-jane. Ann Arbor, Mich.; Univ. of Michigan (1970). 116p. University Microfilms Order No. 70-21,687.

Thesis.

A theoretical model is presented for the mechanisms of formation and dissipation of the collisionless bow shock of the Earth, the precursor oscillation radiated by the shock propagating in the upstream direction of the solar wind, and the ballistic effects that carry the turbulent information from the shock layer generating the random oscillations in the magnetosheath. An analysis is proposed of the wave-generation mechanism due to the inhomogeneities in the interplanetary magnetic field, temperature, and number density of the nonisothermic high-β solar-wind plasma. A high Mach- and Alfven–Mach-number solar wind approaches the dipole magnetic field of the Earth. The high Mach and Alfven–Mach number indicates that the flow should correspond to a hydromagnetic shock wave as approximated in a gasdynamic analogy although the physical mechanisms included are quite different from a gasdynamic shock in this case. The wave system generated by the inhomogeneities of the solar-wind plasma causes a firehose instability and ion-stream oscillation that produces the random oscillation inside the shock. As the waves grow, the velocity slope in the resonant region becomes steepened. It follows that diffusion and enhanced Landau damping are strong enough to suppress the wave system in the shock layer. The shock thickness was shown

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to be of the order of the ion-Larmor radius for a high-β plasma in which thermal ion particles dominate the wave–particle interaction. It is shown that Alfven and ion-acoustic waves, which are insensitive to diffusion and Landau damping, carry the information from the shock layer with phase mixing to relatively long distances. This distance is shown to be of the order of the thickness of the magnetosheath behind the bow shock. The precursor wave, which appears in front of the bow shock, is suggested to be the ion-drift wave due to a temperature gradient. This is a low-frequency left-circularly polarized wave with the superimposed Doppler-shifted frequency. This model again agrees with the observations. In this analysis, a Vlasov–Maxwell system with quasi-linear formulation is adopted. (Diss. Abstr. Int., B)

17039 MID-LATITUDE ATMOSPHERIC EMISSION OF N_2^+ FIRST NEGATIVE BANDS. Jacka, F.; Schaeffer, R. C.; Freund, J. T. (Univ. of Adelaide). Nature (London); 228: 984-5(5 Dec 1970).

The first negative bands of N_2^+ are excited in the atmosphere by energetic-particle precipitation. Some photometric measurements on the O I band at 4278 Å made at Adelaide since August 1969 are described. It is concluded that the nighttime intensity of the O I band does not normally exceed 0.1 Rayleighs, implying a maximum total ionization rate of the order of 10^7 (cm^2 column)$^{-1}$ sec^{-1}. Compared with the loss rate of ions through dissociative recombination in the F region, this rate is small and cannot be regarded as a major factor in the maintenance of the ionization through the night. It is also small compared with the ion-production rate due to cosmic radiation. Since the ionization peaks below 30 km it is assumed that about 75% of the ions are N_2^+, leading to an intensity of approximately 1 Rayleigh for the O I band. This estimate, however, makes no allowance for quenching of the 0 level of N_2^+, from which the emission arises. In the 15- to 30-km region, where ion production by cosmic radiation is greatest, the number density of N_2 is greater than 3×10^{17} cm^{-3}, and the quenching term is large compared with the emission term, resulting in reduction of the intensity of the O I band excited by cosmic radiation to a very small fraction of 1 Rayleigh. Even at heights of 80 km the quenching term may be significant in estimating the ion-production rate or particle-energy flux from intensity of the N_2^+ first negative bands. This is particularly relevant to the study of polar-cap events associated with proton precipitation. (UK)

17040 NOCTURNAL VARIATION OF THE INTENSITY AND ROTATIONAL TEMPERATURE OF THE OH(8,3) BAND IN THE AIRGLOW. Fiocco, G. (European Space Research Inst., Frascati, Italy); Visconti, G.; Congeduti, F. Nature (London); 228: 1079-80(12 Dec 1970).

The results of measurements of the intensity and excitation temperature of the OH(8,3)-vibrational rotational band, carried out with a simple spectrophotometer, are discussed. The filter employed could be tilted to scan the band between 7300 and 7403 Å, and the filtered light was detected with a cooled photomultiplier and photon counting was accomplished with a multichannel analyzer. The experimental spectra were compared with synthetic spectra obtained by considering the theoretical contribution of all lines in the band under the assumption of thermal equilibrium. Best values for the relative intensity and the rotational temperature were obtained nightly at one-hour intervals, during July to December 1968 and during the same months of 1968, from near l'Aquila. Graphs of the average variations of rotational temperature and intensity are shown; a decreasing trend was evident for both during the night. The variation was probably due to the decrease in the OH* production rate associated with the decrease in ozone and hydrogen concentrations at night near the mesopause. The measurements were thought to be relatively immune from contamination by other airglow emissions because of their selectivity and the reduction procedure for the data. It is pointed out that intensity measurements can be affected by variations in atmospheric transparency, but measurements of rotational temperature are less sensitive in this respect. The latter, however, are difficult to interpret since OH emission takes place at heights where radioactive and collisional-deactivation processes are competitive, and because rotational temperature may not reflect the ambient temperature. This is discussed in terms of the Hesstvedt model. Experimental work is in preparation to determine simultaneously the kinetic temperature of OH lines and the rotational temperature of two OH bands. (UK)

17041 DISTURBANCE DAILY VARIATION DURING THE IGY. Petersons, H. F. (Australian National Univ., Canberra). Aust. J. Phys.; 23: 905-25(Dec 1970).

The disturbance daily variation field SD was studied for the three seasons using IGY data from 50 observatories. Equivalent external and internal electric current systems that could account for the SD field were obtained by the method of spherical harmonic analysis. The external current systems were found to be only approximately symmetrical about the geomagnetic equator. The internal current systems, although less intense, had a similar pattern to the corresponding external current systems, thus suggesting that the internal current systems are induced by the corresponding external current systems. (auth) (Australia)

17042 NATURALLY AND ARTIFICIALLY INJECTED TRAPPED PARTICLES, INJUN 1 SATELLITE DATA. Fennell, Joseph Francis. St. Louis; St. Louis Univ. (1969). 105p. University Microfilms Order No. 70-20,382.

Thesis.

Angular distributions from data acquired by the satellite Injun 1 during two time periods (June 30 to July 8, 1961 and June 15 to August 8, 1962) are analyzed and compared with the results of other investigators. A diurnal variation in the half-width at half maximum of the angular distributions of electrons ($E_e > 40$ keV) is observed. The local-noon distributions are wider by at least 6° than those of local midnight for $L > 4.0$. Precipitating electron fluxes of 4×10^5 cm^{-2} sec^{-1} ster^{-1} at auroral altitudes are observed for $L > 5$. The natural electron fluxes perpendicular to B near $L = 1.3$ are shown to be nearly the same ($\sim 10^6$ cm^{-2} sec^{-1} ster^{-1}) for June–July 1961 as for August 1958. The angular distributions of post-Starfish radiation yield electron fluxes perpendicular to B of about 2.6×10^7 cm^{-2} sec^{-1} ster^{-1}, 7.6 hours after the event. At $L = 1.2$ no change in half-width at half-maximum was observed between pre- and post-Starfish radiation. The $E_e > 40$ keV post-Starfish electrons yield 1/e decay times of about 6, 66, and 140 days at $L = 1.2$, 1.25, and 1.75, respectively, and also yield fluxes that are about one to two orders of magnitude larger than those observed for TEAK and one order of magnitude larger than for the ARGUS events. (Diss. Abstr. Int., B)

17043 POWER SPECTRA OF COSMIC-RAY INTENSITY VARIATIONS AT THE GROUND AND ATMOSPHERIC PRESSURE OSCILLATIONS. Dhanju, M. S. (Physical Research Lab., Ahmedabad, India). Planet. Space Sci.; 18: 1719-28(Dec 1970).

Power-spectrum estimates are computed for cosmic-ray and pressure variations in the frequency range of 1.6×10^{-6} to 4.15×10^{-3} c/sec for three data sets each of 27-days length (2 min interval) recorded at Chacaltaya (Bolivia) during 1965–66. The general trend of these spectra show an $f^{-\alpha}$ fit having exponent values from −1.5 to −1.9 for the lf side. From the semidiurnal peaks both in cosmic rays and pressure, the average value of pressure coefficient is found to be 0.3%/mm of Hg. For the same three sets of data, a detailed analysis of the cross spectrum, coherence, and phase relationship between cosmic rays and pressure is carried out in the frequency range of 1 to 12 c/day. Besides the semidiurnal peak, variations of 3, 4, 7, and 8 c/day are found to be common both in cosmic rays and pressure. The value of pressure coefficient and residual amplitude of cosmic rays for these particular frequencies are calculated. (auth) (UK)

17044 ANTENNA IMPEDANCE IN THE LOWER IONOSPHERE. Bishop, Richard Hugh. Salt Lake City; Univ. of Utah (1970) 162p. University Microfilms Order No. 70-22,299.

Thesis.

The theoretical behavior of the impedance of a short cylindrical antenna in an ionospheric plasma as a function of the driving frequency is investigated. The study begins by reviewing plasmas in general and ionospheric plasmas in particular. Methods of measuring the various plasma parameters are then discussed with the emphasis on rf antenna probes. A need for further study of measurement techniques in the collision-dominated D region of the ionosphere is then pointed out. The investigation then turns specifically to the study of the impedance of an antenna probe in the lower collision-dominated part of the ionosphere. From the Boltzmann equation's statistical description of the plasma, the first three moment equations are then found and solved along with Poisson's and Maxwell's equations to give an expression of the antenna impedance. The special case where the magnetic field is parallel to the antenna axis is most easily evaluated. The theoretical results are computed and compared to previous work and to experimental results. The more general case in which the magnetic field is randomly oriented is considered next. In this case the impedance is found using a perturbation technique. The results indicate that the impedance is not a function of the orientation angle between the magnetic field and the antenna axis. Experimental evidence is then presented that agrees with this result. The theoretically derived expression for antenna impedance is then used to compute the expected impedance at various altitudes in the collision-dominant D region of the ionosphere. A study of the predicted impedance behavior is found to indicate a new method of measuring electron density in the D-region. (Diss. Abstr. Int., B)

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17045 ELECTRON INTENSITY VARIATIONS IN THE INNER BELT FOLLOWING A GEOMAGNETIC STORM. Tomblin, F. F. (Bellcomm Inc., Washington, D. C.); Kreplin, R. W. Nature (London); 228: 988-90(5 Dec 1970).

A 3-month study is described of the electron-flux levels following the solar flare of May 23, 1967. These levels, above 120 keV, were monitored by ionization chambers, also used as solar x-ray monitors on OGO IV in polar orbit. Supplementary electron data above 280 keV were also monitored in polar orbit. Nighttime particle data were obtained for the region of the S. Atlantic Anomaly. OGO IV data covered L shells from 1.3 to 1.8 and B fields from 0.18 to 0.25 G; somewhat smaller fields were covered by 1963 38C due to its higher orbit. Solar activity was considerable during late May 1967, and the 3B flare of May 23 appeared to be associated with the geomagnetic storm of May 26th. A storm on September 21 also appeared to be associated with two 2B flares occurring 3 days earlier, and a very striking rapid change in electron flux was observed following this storm; 25 days following the storm the flux had decreased on all L shells and fields covered by OGO IV, and the largest response was at L = 1.4 and B = 0.22 G, where the flux was reduced to one-third initial value in 8 days. Effects of a smaller storm on September 28 were also observable, and the electron population appeared to respond more rapidly to this storm, particularly at weaker fields. (UK)

17046 METHOD FOR ANALYZING DRIFTING RANDOM PATTERNS IN ASTRONOMY AND GEOPHYSICS. Little, L. T.; Ekers, R. D. (California Inst. of Tech., Pasadena). Astron. Astrophys.; 10: 306-9(Jan 1971).

The motion of a drifting random pattern is considered in terms of a model pattern whose spatial Fourier components move over the ground with different velocities. The effect of a varying random component of velocity on the frequency spectrum observed at a single receiver is discussed, together with its relevance to observations of interplanetary and interstellar scintillation. The limitations of the current methods of analysis used to obtain drift velocities from observations made at a limited number of spaced receivers are pointed out, and a new method is presented. (auth)

17047 AURORAL IONIZATION AND INCIDENT MAGNETOSPHERIC ELECTRONS. Catchpool, J. R. (York Univ., Toronto). Can. J. Phys.; 48: 2537-41(1 Nov 1970).

A model is studied in which the supply of energetic electrons from a spiraling magnetospheric path to auroral atmospheric heights is considered. In particular, a calculation is made of the effect on atmospheric penetration that might be expected as a result of the combined influence of two magnetospheric-accelerating mechanisms: (a) magnetic-line convergence and (b) the superposition of a parallel electric field. This determination depends on details of energy and pitch-angle distributions for precipitated electrons, and is made with reference to an isotropic distribution in the equatorial plane. Results indicate the significant control by magnetospheric electric fields on auroral ionization. (auth) (Canada)

17048 RELATION OF SOLAR WIND PARAMETERS TO PERIODS OF STABLE MICROPULSATIONS OF THE EARTH'S ELECTROMAGNETIC FIELD. Gringauz, K. I.; Troitskaya, V. A.; Solomatina, E. K.; Shchepetnov, R. V. Dokl. Akad. Nauk SSSR; 194: 1069-71(11 Oct 1970). (In Russian).

The results of measuring solar-wind ion fluxes, which were carried out by means of charged-particle traps on interplanetary ships Venus-2 (in 1965), Venus-4 (1967), and also Venus-5 and Venus-6 (1969), were compared with simultaneous measurements of the periods T of stable micropulsations of the Earth's electromagnetic field. Observation intervals about a month from the time of launching, when the vessels were sufficiently near to Earth, were chosen for comparison. For all four space probes the variation of the periods T of the micropulsations as a function of the particle flux was different for two different ranges of values of T. At $T < 40$ sec a decrease in T was observed with increasing particle flux n, while at $T > 40$ sec, the value of T increases with increasing particle flux n. The value of T practically does not depend on the solar-wind velocity, but is determined mainly by the particle concentration. The pulsations of less than 60-sec period were thought to be associated with the generation of pulses inside the cold-plasma shell of the Earth (the plasmosphere). The pulsations with the longer period are associated with an increase in plasma concentration in interplanetary space. (TTT).

17049 WARMING OF THE UPPER ATMOSPHERE DURING GEOMAGNETIC STORMS AND AURORAS. Truttse, Yu. L. Cosmic Res. (USSR) (Engl. Transl.); 8: 272-8(Mar-Apr 1970).

Translated from Kosm. Issled.; 8: 298-305(Mar-Apr 1970).

The published data are used to compare changes in the density of the atmosphere in the region of low latitudes with changes in solar and geomagnetic activities characterized by $F_{10.7}$ and AE indices, respectively. The dependence of the altitude course of the change in atmospheric density on solar activity differs from that on geomagnetic activity. The explanation of this is that sources responsible for expansion of the upper atmosphere are located at different altitudes. The relationship between density and the AE indices is linear, within the limits of error, throughout the range of change in these indices and it remains the same for different levels of solar activity. The relationship between density and the $F_{10.7}$ index is highly nonlinear. There are grounds for considering that the density of the upper atmosphere is related, not only to the $F_{10.7}$ flow, but also to another source. The behavior of the intensity of the red oxygen emission at 6300 Å is also examined, and it is shown that this emission is localized outside the region of low latitudes. (auth)

17050 MEASUREMENT OF IONOSPHERIC ELECTRON CONCENTRATION BY MEANS OF A HIGH-FREQUENCY IMPEDANCE PROBE. Komrakov, G. P.; Ivanov, V. P.; Popkov, I. V.; Tyukin, V. N. Cosmic Res. (USSR) (Engl. Transl.); 8: 255-9(Mar-Apr 1970).

Translated from Kosm. Issled.; 8: 278-83(Mar-Apr 1970).

A brief description is given of an apparatus used to measure the electron concentration in the ionosphere by means of a high-frequency impedance probe; the electron-density distribution obtained with this device at heights from 80 to 170 km is given. (auth)

17051 RESULTS OF MEASUREMENTS OF CHARGED-PARTICLE CONCENTRATION IN THE EARTH'S PLASMA ENVELOPE MADE ABOARD THE ELEKTRON 2 AND ELEKTRON 4 SATELLITES. Bezrukikh, V. V. Cosmic Res. (USSR) (Engl. Transl.); 8: 251-4(Mar-Apr 1970).

Translated from Kosm. Issled.; 8: 273-7(Mar-Apr 1970).

Distributions of n_i in the Earth's plasma envelope as measured on the Élektron 2 and Élektron 4 during the morning and evening hours of local time are presented. It is noted that most of the n_i distributions obtained have a sharp break (knee) whose distance from the Earth depends on geomagnetic activity. (auth)

17052 SPATIAL DISTRIBUTION AND TIME VARIATIONS OF SOFT-ELECTRON FLUXES IN THE EARTH'S MAGNETOSPHERE ACCORDING TO DATA FROM THE CHARGED-PARTICLE TRAP ON ELEKTRON 2 AND THEIR RELATION TO THE ORIENTATION OF THE EARTH'S MAGNETIC DIPOLE. Kokhlov, M. Z. Cosmic Res. (USSR) (Engl. Transl.); 8: 241-50 (Mar-Apr 1970).

Translated from Kosm. Issled.; 8: 261-72(Mar-Apr 1970).

The spatial distribution and time variations of soft-electron (~0.1 to 10 keV) fluxes are discussed on the basis of data from a charged-particle trap mounted on the Elektron 2 satellite. The measurements (January 30 to June 2, 1964) cover the interval from 10–0–16 h local geomagnetic time. The fluxes were observed in the invariant-latitude range from ~60 to 80°. The intensity ranged up to about 5×10^9 cm^{-2} · sec^{-1} and sometimes even higher. A marked asymmetry in the distribution of the fluxes about the morning–evening line (the fluxes are stronger in the daytime magnetosphere) is detected, and the time variations are found to be related to the orientation of the Earth's magnetic dipole relative to the direction to the Sun. A positive correlation is observed between the flux intensities and the A_p index of geomagnetic activity. (auth)

17053 ADIABATIC ATTRACTION OF QUASI-TRAPPED CHARGED PARTICLES BY THE GEOMAGNETIC FIELD DURING THE RECOVERY PHASE OF A MAGNETIC STORM. Pletnev, V. D.; Shalimov, V. P. Cosmic Res. (USSR) (Engl. Transl.); 8: 231-40(Mar-Apr 1970).

Translated from Kosm. Issled.; 8: 251-60(Mar-Apr 1970).

A model is discussed for the deformation of a magnetic field in the trapped-radiation region during a magnetic storm. The displacement of the individual charged particles and their acceleration are treated under the assumption that all three adiabatic invariants are conserved. An expression is derived for the spatial distribution of particles leaving the quasi-trapping region to go to the trapped-radiation region during the recovery phase of a magnetic storm. (auth)

Low-Temperature Physics and Cryogenic Equipment

Superfluidity

17054 SIZE EFFECTS IN He II AS MEASURED BY FOURTH SOUND. Kriss, M.; Rudnick, I. (Univ. of California, Los Angeles). J. Low Temp. Phys.; 3: 339-57(Oct 1970).

Fourth-sound measurements are used to determine the depletion in the superfluid density ρ_s, which occurs in the helium-filled small pores of packed powders. The measurements also give the reduction in superfluid onset temperature. The pore size distribution of several samples was determined from desorption isotherms. Using this distribution and an independent pore model, calculations based on the Ginzburg–Pitaevskii ansatz with a healing length first proposed by Mamaladze are found to be in good agreement with experimental results in several cases. The superfluid onset temperature seems to be determined by the average pore size. Fourth-sound measurements as a function of temperature T in large pore geometries accurately give $\rho_s \sim (T_\lambda - T)^{\frac{1}{2}}$ in the neighborhood of the lambda temperature T_λ. (auth)

17055 GROUND STATE OF ^{4}He MONOLAYERS ADSORBED ON INERT SUBSTRATE. Campbell, C. E.; Schick, M. (Univ. of Washington, Seattle). Phys. Rev., A; 3: 691-6(Feb 1971).

The properties of a system of ^{4}He atoms are investigated at the absolute zero of temperature interacting via a Lennard–Jones potential, and constrained to motion in two dimensions by an otherwise inert substrate. Results of a semiclassical calculation indicate that the ground state is that of a self-bound liquid. It further indicates that a close-packed-solid configuration is not self-bound. A quantum-mechanical variational calculation is performed to obtain an upper bound on the energy of the system. A result of -0.61°K per particle is obtained at a density of 0.035 Å^{-2}. The relationship between this calculation and recent experiments on ^{3}He monolayers is briefly discussed. (auth)

17056 DENSITY OF He II IN SUPERFLUID FLOW. Rosenshein, J. S.; Taube, J.; Titus, J. A. (Univ. of Florida, Gainesville). Phys. Rev. Lett.; 26: 298-301(8 Feb 1971).

The density of He II in supercritical, superfluid flow has been measured by a sensitive capacitance technique in the temperature range from 1.3 to 1.8 K. The average density of the liquid decreased with increasing superfluid velocity. The largest fractional density change observed was $\Delta\bar{\rho}/\rho = -9 \times 10^{-4}$ at a velocity of 7.75 cm/sec. The results can be accounted for adequately by the two-fluid, thermohydrodynamic equations of motion utilizing the expressions for the nonlinear, superfluid dissipation force and the mutual friction force. (auth)

17057 COMMENTS ON LONG-WAVELENGTH EXCITATIONS AND STRUCTURE FUNCTIONS IN THE THEORY OF LIQUID ^{4}He AT T = 0. Feenberg, E. (Washington Univ., St. Louis). Phys. Rev. Lett.; 26: 301-3(8 Feb 1971).

Polynomial approximations for the liquid structure function S(k) and the energy of an elementary excitation $\epsilon(k)$ are found to contain both odd and even powers of k if the interatomic potential falls off asymptotically as r^{-6}. The proof is given under conditions of low density and weak interaction and hence has only suggestive force in applications to the real superfluid. (auth)

17058 DECAY OF PERSISTENT CURRENTS OF SUPERFLUID HELIUM. Kukich, George. Ithaca, N. Y.; Cornell Univ. (1970). 93p. University Microfilms Order No. 70-23,123.

Thesis.

Using the superfluid gyroscope technique, the temperature dependence of the superfluid density, ρ_s/ρ, and the critical velocity, $v_{s,c}$, were measured for persistent currents of superfluid helium flowing through pores of 2000, 500, and 38 Å diameter. For all three geometries, for flow velocities near the critical velocity the superfluid persistent currents were observed to decay with a logarithmic time dependence. For each geometry, the temperature dependence of the decay rate was measured and can be related to the corresponding ρ_s/ρ and $v_{s,c}$ data in a self-consistent manner in terms of a thermal activation picture. Predictions of specific models of thermally activated, homogeneously nucleated dissipative excitations are compared to the data and found to be in qualitative agreement with the experimental results. This work gives strong experimental support to the thermal activation theory of the critical velocity of superfluid helium advanced by Langer and Fisher, which asserts that states of nonzero superflow are metastable states. (Diss. Abstr. Int., B)

17059 NUCLEATION OF ULTRASONIC CAVITATION BY ALPHA-PARTICLE IRRADIATION OF LIQUID HELIUM. Shadley, J. R.; Finch, R. D. (Univ. of Houston, Tex.). Phys. Rev., A: 3: 780-5(Feb 1971).

It has been shown that the presence of an α-particle emitter causes a lowering of the ultrasonic-cavitation-noise threshold in helium II by as much as 50%. The lowest temperature investigated was 1.80°K. There was no discernable effect on the threshold in helium I, so that the nucleation mechanism cannot be the formation of microbubbles at hot spots as in Seitz's theory. Neither the presence of a β source nor electric fields affected the nucleation, so that ions, per se, are also ruled out as a nucleating mechanism. However, several similarities to the behavior of the threshold in rotating helium were observed. Evidence was obtained indicating that the cavitation noise was localized in the vicinity of the α source. It is concluded that the nucleation occurs on vortex filaments created by the α particles. (auth)

17060 HIGH-FIELD BEHAVIOR OF IONS IN He II. Padmore, Timothy C. (Georgia Inst. of Tech., Atlanta). Phys. Rev. Lett.; 26: 63-6(11 Jan 1971).

A theory of the motion of ions in He II which takes into account ion–vortex-ring nucleation and escape probabilities is described. Predictions of the theory are compared with available experimental data and suggestions are made for further experiments. (auth)

17061 EXCITATIONS RADIATED FROM A THERMAL SOURCE IN HELIUM II BELOW 0.3K. Guernsey, R. W. Jr.; Luszczynski, K. (Washington Univ., St. Louis). Phys. Rev., A; 3: 1052-60(Mar 1971).

Results are presented on the propagation of excitations generated by a small (~1 mm square) pulsed heater immersed in a large (~300 cc) sample of He II maintained at temperatures below 300 mK. Small carbon-film detectors placed at 1, 2, 3, and 4 cm from the heater are used to measure the flux of radiation over a wide range of heater-power densities (W_H). The observed signals are free from wall reflections. At the lowest temperatures and small W_H, the fastest excitations propagate without dispersion or attenuation at a velocity of 234 ± 4 m/sec. Spatial attenuation, which is observed at higher temperatures, corresponds to effective mean free paths for large-angle scattering of 1, 2, and 3 cm at 306 ± 6, 272 ± 6, and 254 ± 8 mK, respectively. When W_H exceeds 0.4 W/cm^2, signal shapes reflecting appreciable interactions between radiated excitations are observed. For $W_H >$ 2.9 W/cm^2, the observed signal acquires another component that propagates without appreciable dispersion at a velocity of 200 ± 10 m/sec. In these experiments, no evidence was found of any excitations associated with any upward bend in the He II phonon-dispersion curve resulting in signal velocities in excess of the first-sound velocity. (auth)

17062 PROPAGATION OF COOL PULSES IN LIQUID He II. Pomerantz, M. (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev. Lett.; 26: 362-4(15 Feb 1971).

Pulses of heat were applied to liquid He and it was found that, below the λ transition, pulses of lower-than-ambient temperature propagate in the He II. This "cool" pulse is attributed to the temperature change that accompanies a compressive first-sound pulse. The temperature pulse is negative because the thermal expansion of He II is negative near the λ transition. (auth)

17063 ^{3}He CONCENTRATION WAVES AS TYPE OF TEMPERATURE WAVES IN ^{3}He–He II SOLUTIONS. Galasiewicz, Z. M. (Univ. of Wroclaw. Inst. of Low Temperatures and Structure Research, Warsaw). Phys. Lett.; 34A: 7-8(25 Jan 1971).

It is demonstrated that the excitation of standing-temperature waves leads to the appearance of standing ^{3}He concentration waves in ^{3}He–He II solutions. (auth)

17064 DIFFUSION COEFFICIENT OF ^{3}He IN ^{3}He–^{4}He SOLUTIONS. Chang, Donald Choy. Houston, Tex.; Rice Univ. (1970). 123p. University Microfilms Order No. 70-23,488.

Thesis.

The transport properties of ^{3}He in ^{3}He–^{4}He solutions with molar concentration of 5, 9, 14 and 24% ^{3}He were studied for 0.9°K ≤ T ≤ 2.5°K. A spin-echo technique (method "B" of Carr and Purcell) was employed to measure the diffusion coefficient and longitudinal relaxation time for temperatures both above and below the solution lambda temperature, T_λ. The study indicates the diffusion of ^{3}He in the solution behaves remarkably differently in the two temperature regions divided by T_λ. In the He-I region, i.e., above T_λ, the diffusion coefficient is independent of ^{3}He concentration, and the behavior is more or less similar to that of pure liquid ^{3}He. As the solution undergoes the lambda phase transition, no discontinuity is found. Below T_λ, the diffusion is highly sensitive to the concentration of ^{3}He. Previous theoretical calculations based on dilute solution model seem inadequate to explain our data. The results suggest that the ^{3}He–^{3}He scattering, which has been neglected by some theoreticians above 1°K, is important for solutions whose concentration is not very dilute (5% or more). Our measurements also clearly indicate that there are two different contributions to the diffusion of ^{3}He in solutions. The part which is contributed by the ^{3}He–roton scattering is independent of ^{3}He concentration. The other part, which is due to ^{3}He–^{3}He scattering, is inversely proportional to the concentration of He. This shows that in the temperature range of the experiments the ^{3}He atoms obey Boltzmann statistics, as theoretically expected. The data also suggests that the ^{3}He–^{3}He interaction in He-II solutions can not be explained in a

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hard-sphere model. A quasi-particle treatment seems necessary. No complete satisfactory theory has yet been found. (Diss. Abstr. Int., B)

17065 PROPOSAL FOR MEASUREMENT OF HELIUM-II CONDENSATE. Cummings, F. W. (Queen Mary Coll., London); Hyland, G. J.; Rowlands, G. Phys. Kondens. Mater.; 12: 90-6 (1970).

The method proposed for experimental determination of the equilibrium condensate fraction in ^{4}He II relies only on measurement of the liquid structure factor as a function of temperature. Existing data at 0.79 and 1.4°K indicate the value to be about 10%. (auth)

17066 CONSISTENT FORM OF REDUCED DENSITY MATRICES OF SUPERFLUIDS. Lal, P.; Terreaux, C. (Univ. of Liverpool). Phys. Kondens. Mater.; 12: 131-7(1970).

An attempt is made to derive a systematic expression of the second-order reduced density matrix Ω_2 in the case of a condensed system of identical spinless bosons. The derivation lends itself to generalization leading to higher-order reduced density matrices Ω_n, $n > 2$, that are consistent with the hierarchical set of equations of motion for the different Ω_n. (auth)

17067 ^{3}He SPIN DIFFUSION IN DILUTE ^{3}He–He II MIXTURES AT ELEVATED PRESSURES IN THE SEMICLASSICAL REGIME. Biegelsen, D. K.; Luszczynski, K. (Washington Univ., St. Louis). Phys. Rev., A; 3: 1060-7(Mar 1971).

Measurements of the spin-diffusion coefficient in dilute ^{3}He–He II mixtures are presented. The thermodynamic parameters of the samples are varied within the following limits: $0.3 \leq T \leq 1.15$°K, saturated vapor pressure $\leq P \leq 24$ atm, $0.322 \times 10^{-4} \leq n_3 \leq 4.54 \times 10^{-4}$ mole/cm^3. It is shown that all samples considered are within the limits of the semiclassical regime. The data are analyzed by considering the reciprocal of the diffusion to be the sum of two parts: $1/D(T,P,n_3) = 1/D_{3\rho}(T,P) + 1/D_{33}(T,P,n_3)$, where $D(T,P,n_3)$ is an experimental measurement at (T,P,n_3), $D_{3\rho}(T,P)$ is the n_3-independent spin diffusion of a ^{3}He quasi particle as limited by interactions with rotons, and $D_{33}(T,P,n_3)$ is the spin diffusion of a ^{3}He quasi particle limited by interactions with other ^{3}He quasi particles. Since $D_{3\rho}$ is independent of n_3, and D_{33} is shown to be proportional to n_3^{-1}, a least-squares fit of the data to the above equation gives the experimentally determined values of $D_{3\rho}$ and D_{33}. A comparison of D_{33} with the theoretical expression gives directly the moment of the effective ^{3}He–^{3}He interaction measured by spin diffusion in the semiclassical regime: $\langle V(k)\rangle|_{T,P} = A\int e^{-ak^2}k^3|V(bk)|^2\,dk$, where A, a, and b are constants. The measurements are insufficient to determine V(k) uniquely. Calculations using an assumed interaction (which reduces to the interaction used by Ebner at saturated vapor pressure) show a remarkable similarity to the experimental data. (auth)

17068 HIGH-ENERGY NEUTRON SCATTERING MEASUREMENTS ON LIQUID HELIUM AND BOSE CONDENSATION IN He II. Harling, O. K. (Battelle-Northwest, Richland, Wash.). Phys. Rev., A; 3: 1073-87(Mar 1971).

Differential neutron scattering cross sections for liquid ^{4}He were obtained for momentum transfers along the free-particle excitation curve up to 20.3 Å^{-1}. Momentum transfers in this range are much higher than in previously reported work. The measured recoil energies as well as the angular dependence of the scattering confirm that the neutron scattering, at these high values of κ, is sensitive to the motions of single helium atoms. A temperature dependence in the widths of the cross-section peaks, as well as shape changes in these peaks as the temperature is decreased below T_λ, is consistent with the idea that a narrow condensate component contributes to the scattering for $T < T_\lambda$. Results from a detailed comparison of the measured cross sections with a theory for high-energy neutron scattering are reported. The kinetic energy per liquid-helium atom is deduced from this theory–experiment comparison and is found to be in agreement with computations of the kinetic energy based on thermodynamic phase equilibria considerations. A fractional occupation of the zero-momentum condensate state of $(8.8 \times 1.3)\%$ at 1.27°K is also deduced from this theory–experiment comparison. (auth)

17069 BOSE–EINSTEIN CONDENSATION IN TWO DIMENSIONS. Fernandez, J. F. (Instituto Venezolano di Investigaciones Cientificas, Caracas). Phys. Rev., A; 3: 1104-7(Mar 1971).

It is proven that for Bose–Einstein condensation, in the sense of quasi averages, condensation into any one-particle state is forbidden at nonzero temperatures in any two-dimensional system, whether under rotation or not, regardless of the external potential, so long as the particle density is bounded everywhere. The proof is based on Bogolyubov's inequality. (auth)

17070 COMMENT ON THE THEORY OF QUANTIZED VORTICES. Amit, Daniel J. (Stanford Univ., Calif. Brandeis Univ., Waltham, Mass.). Phys. Rev., A; 3: 1198-9(Mar 1971).

A recent statement that significant differences in the structure of a vortex line appear between the simple Hartree calculation and the variational Jastrow approach is shown to have no basis in reality. (auth)

17071 ^{3}He QUASI-PARTICLE ENERGY IN SUPERFLUID ^{4}He. Ebner, C. (Ohio State Univ., Columbus). Phys. Rev., A; 3: 1201-2(Mar 1971).

A simple classical model is used to estimate the deviations of the ^{3}He quasi-particle energy in ^{4}He at T = 0 from the parabolic form $\epsilon(p) = -E_0 + p^2/2m$. The result is in reasonable agreement with a recent experimental determination of this effect. (auth)

17072 INTERATOMIC POTENTIAL IN LIQUID ^{4}He. Sposito, Garrison (Sonoma State Coll., Ronert Park, Calif.). J. Low Temp. Phys.; 3: 491-8(Nov 1970).

The validity of the traditional Lennard-Jones (6,12) potential as applied to liquid ^{4}He is examined and alternatives are considered. The Lennard-Jones potential is found to be subject to a number of serious defects, the worst among them that it does not satisfy the virial theorem. In its place it is proposed to use the Morse–V_{DD} potential function, which has none of the flaws in the Lennard-Jones potential and has the convenient feature of possessing a Fourier transform. The parameters appropriate to liquid ^{4}He are computed for the new potential, as are a number of quantities derivable from it that are of current theoretical interest. Values of these quantities as they are obtained using both potential functions are compared. (auth)

17073 THEORY OF THE OSMOTIC PRESSURE OF DILUTE MIXTURES OF ^{3}He IN LIQUID ^{4}He AT LOW TEMPERATURES. Emery, V. J. (Brookhaven National Lab., Upton, N. Y.). J. Low Temp. Phys.; 3: 499-507(Nov 1970).

The osmotic pressure π of dilute mixtures of ^{3}He in liquid ^{4}He is calculated and compared with experiment. One parameter, which is a measure of the difference between the mean potential energy of ^{3}He atoms and ^{4}He atoms in the mixture is determined from the experiments, and good agreement is obtained with the measured values of π as a function of concentration and temperature. It is shown that the osmotic pressure does not provide any accurate information about the effective interaction between ^{3}He atoms. A comparison with earlier calculations of the osmotic pressure and of the ^{3}He chemical potential is made. (auth)

Superconductivity

Refer also to abstracts 16518, 16525, 17319, 17337, and 17403.

17074 COMPENSATION OF THE PARAMAGNETIC EFFECT ON H_{c2} BY MAGNETIC IMPURITIES. Fischer, Oe.; Jones, H.; Bongi, G.; Frei, C.; Treyvaud, A. (Univ., Geneva). Phys. Rev. Lett.; 26: 305-8(8 Feb 1971).

An anomalous behavior of the upper critical field is found for the superconducting system $Mo_{1-x}Mn_xGa_4$. It is suggested that this is due to the compensation of the paramagnetic term in the Hamiltonian, $-g\mu_B\vec{H}\cdot\vec{\sigma}$, by a negative exchange interaction $cJ(\vec{S}\cdot\vec{\sigma})$. (auth)

17075 ZITTERBEWEGUNG OF QUASI PARTICLES IN SUPERCONDUCTORS. Lurie, D.; Cremer, S. (Technion-Israel Inst. of Tech., Haifa). Physica; 50: 224-40(1970).

It is shown that a Bogolyubov quasi-particle in a superconductor undergoes a trembling motion (Zitterbewegung) similar to that undergone by a relativistic quantum particle. The velocity operator of a quasi-particle is exhibited as the sum of a mean velocity operator— representing the "average" motion of the quasi-particle—and a second term representing a rapidly oscillating motion over distances of the order of the coherence length $\xi_0 = (v_F/\pi\Delta) \approx 10^{-4}$ cm. The Foldy–Wouthuysen transformation is applied to exhibit the parallel decomposition of the position operator x into a mean position part X and an oscillatory Zitterbewegung contribution x–X. The mean position operator is shown to be an integral operator in x space with a kernel $X(x-x')$ that tends rapidly to zero for separations $|x-x'|$ greater than the coherence length ξ_0. The physical interpretation of Zitterbewegung within the framework of the many-particle theory is discussed. It is shown that Zitterbewegung reflects the impossibility of localizing a single quasi-particle within a region of dimensions less than $\approx 10^{-4}$ cm. A measurement of position with an accuracy greater than this limit will necessarily create additional quasi-particles and quasi-holes thereby destroying the single-particle character of the state. (auth)

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17076 TRANSITION METAL SUPERCONDUCTIVITY IN A GENERALIZED Nb_3Al SYSTEM. Cadieu, F. J. (Univ. of Chicago). J. Low Temp. Phys.; 3: 393-414(Oct 1970).

The variation of the superconducting transition temperature T_c in $(Nb_{1-y}M_y)_3-Al_{1-x}Ge_x$ composite systems, where M is one of the IVB transition elements Ti, Zr, or Hf, was studied. It was found that the transition-metal group dominates in determining the T_c of the system. The variation of T_c is shown to be similar for all three IVB elements, reflecting the similarity of the behavior of T_c for $Nb_{1-y}M_y$ binary alloys. The behavior of the binary alloys is analyzed in terms of the McMillan equation to test the importance of the electronic density of states N(O) in determining the electron–phonon coupling constant λ. The T_c variation for M equal to Zr was investigated for the entire range of x and y from 0 to 1. The transition temperature is qualitatively independent of x suggesting that only physical quantities relevant to the transition metal alone influence the transition temperature. (auth)

17077 ELECTROMAGNETIC INTERACTION OF QUASI PARTICLES IN SUPERCONDUCTORS. Cremer, S.; Lurie, D. (Technion–Israel Inst. of Tech., Haifa). J. Low Temp. Phys.; 3: 439-49(Oct 1970).

The effect of "superconductive Zitterbewegung" on the electromagnetic interaction of quasi-particles in superconductors is discussed. It is shown that Zitterbewegung is responsible for the appearance, in the interaction Hamiltonian, of Darwin-like terms proportional to the divergence of the electric field strength. The appearance of these terms reflects the fact that in its interaction with the electromagnetic field the quasi-particle feels the averaged effect of the field over distances of the order of the Pippard coherence length $\sim 10^{-4}$ cm. (auth)

17078 FLUCTUATION–DISSIPATION RELATION AND ITS APPLICATIONS TO THERMODYNAMIC FLUCTUATIONS IN SUPERCONDUCTING CYLINDERS. Leung, M. C. (Univ. of British Columbia, Vancouver). J. Statist. Phys.; 2: 305-22 (1970).

Modifying slightly Kubo's formulation of perturbation theory to take care of the fact that generalized susceptibility may not be zero at infinite frequency, a general relation between covariance and generalized susceptibility is established, in the classical limit. The relation is then applied to evaluate the covariances of the magnetic flux, currents, and magnetization of a superconducting cylinder. Expressions for the spectra of magnetic flux and magnetization are also obtained. (auth)

17079 EMPIRICAL APPROACH TO SUPERCONDUCTIVITY. Matthias, B. T. (Univ. of California, San Diego, La Jolla. Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 179-88 of Applied Solid-State Physics. /Low, W. (ed.). New York; Plenum Publishing Corp. (1970).

The cooperative nature of superconductivity is emphasized, and the empirical approach is shown to be the only approach to superconductivity that has had much success in predicting and raising transition temperatures. The correlation of superconductivity with other properties (melting point, magnetism, hardness) is discussed. The points of occurrence of superconductivity in the periodic system are discussed; it is shown why La in the series Sc, Y, La should be replaced by Lu. The complicated behavior of U is considered in some detail. It is felt that there cannot be just one mechanism of superconductivity; that, besides the electron–phonon interaction (lattice deformation), there is also a deformation of the electron shell. The differences in superconducting behavior of transition and nontransition elements are pointed out. For high transition temperatures, the requirements are: electron concentrations of 5 to 7 valence electrons, electron polarization as well as lattice polarization, and cubic structure. (D.L.C.)

17080 SURFACE IMPEDANCE OF GOLD FILMS ON BULK SUPERCONDUCTING TIN. Combet, H. A. (Centre National d'Etudes des Telecommunications, Lannion, France). J. Phys. Chem. Solids; 31: 2607-14(Dec 1970).

The variations of the surface impedance at 4 GHz of gold films evaporated on bulk tin were studied experimentally, as a function of temperature and gold thickness. The results for surface resistance agree with a recent theory by Hurault on nonlocal effects in the electromagnetic response of superconducting contacts. The data for surface reactance show the phenomenon of anomalous penetration predicted by De Gennes and Matricon. The values of the surface impedance when the tin is in the normal state, used to normalize the data, are derived from a theory by Meissner predicting a "normal-state proximity effect." The consistency of the experimental results gives a check of all theories. (auth) (UK)

17081 ENHANCEMENT OF SUPERCONDUCTIVITY IN THIN INDIUM FILMS. Garland, M. M. (Memphis State Univ.). Appl. Phys. Lett.; 18: 47-8(15 Jan 1971).

The effect of elastic tensile stress on the superconducting transition temperature of thin indium films is investigated through the use of specially fabricated substrates. It is found that the transition temperatures may be elevated as much as 0.91°K above the bulk value. (auth)

17082 MARTENSITIC TRANSFORMATION IN THE SYSTEM $Nb_3Sn_{1-x}Al_x$. Vieland, L. J.; Wicklund, A. W. (RCA Labs., Princeton, N. J.). Phys. Lett.; 34A: 43-5(25 Jan 1971).

Replacement of several percent of Sn in Nb_3Sn by Al is found to prevent the low-temperature lattice transformation. A maximum in T_c occurs at the critical concentration of Al. (auth)

17083 X-RAY SPECTRA AND ENERGY BANDS OF SILICIDES AND HIGH-TEMPERATURE SUPERCONDUCTORS OF V_3X TYPE. Dzeganovskii, V. P.; Bondarenko, T. N.; Zhurakovskii, E. A. (Inst. of Problems in Studies of Solids, Kiev). Ukr. Fiz. Zh.; 15: 1488-95(Sep 1970). (In Russian).

L_α bands and K-absorption edges were obtained of vanadium in silicides and in high-temperature superconductors of the V_3X type. The position and intensities of L_α bands were measured. The qualitative distribution of the electronic states in the valence and conduction bands of these compounds was constructed, using all spectral data, and the result was compared with the theoretical curve N(E). Some conclusions are drawn on the character of the changes in the d band and on the nature of the chemical bond in these compounds. (auth)

17084 BAND STRUCTURE AND TRANSPORT PROPERTIES OF SIMPLE CUBIC TELLURIUM-BASE ALLOYS. Newkirk, Lawrence Ronald. Pasadena, Calif.; California Inst. of Tech. (1970). 94p. University Microfilms Order No. 70-24,307.

Thesis.

The electrical transport properties and lattice spacings of simple cubic Te–Au, Te–Au–Fe, and Te–Au–Mn alloys, prepared by rapid quenching from the liquid state, were measured and correlated with a proposed band structure. The variations of superconducting transition temperature, absolute thermoelectric power, and lattice spacing with Te concentration all showed related anomalies in the binary Te–Au alloys. The unusual behavior of these properties was interpreted by using nearly free electron theory to predict the effect of the second Brillouin zone boundary on the area of the Fermi surface and the electronic density of states. The behavior of the superconducting transition temperature and the lattice parameter, as Fe and Mn are added, further supports the proposed interpretation as well as providing information on the existence of localized magnetic states in the ternary alloys. In addition, it was found that a very distinct band-structure effect on the transition temperatures of the Te–Au–Fe alloys could be identified. (Diss. Abstr. Int., B)

17085 INTERACTION OF PHYSISORBED OXYGEN WITH THIN SUPERCONDUCTING TIN FILMS. Wurzbacher, G.; Gebhardt, P. (Battelle-Institut eV, Frankfurt am Main). Surface Sci.; 21: 324-36(Jul 1970).

The influence of oxygen, adsorbed on thin tin films at liquid helium temperature, on the superconducting temperature of the metal film was studied. At this temperature, oxygen is adsorbed as O_2 molecules. At higher degrees of coverage, antiferromagnetically coupled $(O_2)_2$ is formed. The observed phenomena and the quantitative results are interpreted as an interaction of the localized oxygen spins with the spins of the conduction electrons of the metal underneath. (auth)

17086 DYNAMIC RESPONSE OF THE CURRENT-CARRYING SUPERCONDUCTIVE SURFACE SHEATH. Emerson, John Francis. Ithaca, N. Y.; Cornell Univ. (1970). 163p. University Microfilms Order No. 70-24,031.

Thesis.

Cylindrical type-II superconductors (Pb-rich Pb–In alloys) in an axial steady field such that the specimens were in the superconducting surface sheath state were investigated with respect to both axial ac field penetration and axial transport current response. In the ac case the field penetration rate waveform in response to a triangular 110-Hz signal of a few oersteds amplitude was observed directly. The transport current study produced directly the voltage-versus-current curves for the same specimens. Both temperature and steady-field magnitude were systematically varied (1.7 to 4.2°K and 1.1 to 1.6 $H_{c2}(T)$ respectively). The ac field penetration waveforms displayed an initial fully shielded region followed by a transition of finite width yielding finally to a field transparent region. Employing a corresponding two-parameter piecewise linear model waveform, the data was reduced to values for critical (onset of transition) and saturation (onset of transparency) shielding currents (J_c^{ac} and J_f^{ac} respectively). The transport current response showed an essentially resistanceless domain up to a limiting current magnitude identified as critical (i.e., J_c^{dc}) followed by a region of nonohmic, less than normal re-

sistance. It was found that for a given steady field and temperature typically $J_c^{dc} \approx 2J_c^{ac} \approx 4J_c^{ac}$. The fact that the ac screening current and the transport current were orthogonal is noted and leaves anisotropic surface irregularities as a possible source of such discrepancy. With regard to steady field H_a dependence, all three currents were found to be proportional to $(1 - H_a/H_{c3}(T))^n$ where the sheath upper critical field $H_{c3}(T)$ was found to be equal to 1.74 $H_{c2}(T)$ to within 2% for all temperatures investigated, and the exponent n ranged from 2.00 to 3.75 with the value tending to decrease with increasing in content, but little systematic variation between ac and dc results was observed. For a fixed value of $H_a/H_{c2}(T)$ an increase in temperature by a factor of about 2.5 resulted in a decrease in each of the three characteristic currents of only about 20%. Thus, most of the temperature dependence of each of the currents sppears to scale out by employing the same effective field $H_a/H_{c2}(T)$. An interpretation of both modes of sheath response in terms of a fluxspot model quite analogous to the mixed state of bulk type-II superconductors is presented. The existence of fluxspots consisting of flux quanta penetrating the sheath due to a small steady-field component normal to the specimen surface is postulated. Such a normal component may be due to either slight steady-field misalignment of specimen surface irregularities. The current, either screening or transport, should then exert a Lorentz-type force upon the fluxspot. Again, by analogy, both creep (i.e., thermal unpinning dominated) and flow (i.e., viscous drag-dominated) motion of the Lorentz-force-driven fluxspots is considered. While the temperature dependence of the slope of the transition of the ac field penetration results would seem to be in better accord with the creep mechanism, the detailed form of the dc transport current response tends to favor the flow scheme if a spatial distribution of pinning strengths is allowed. Both models, however, are relatively crude and involve some parameters that are not completely understood for the analogous mixed-state bulk fluxoid case and even less so with respect to the surface sheath. Again, of course, the orthogonality of the ac and dc currents, as well as their different relative magnitudes, may play a role in this regard. (Diss. Abstr. Int., B)

17087 THEORY OF THE CURRENT–VOLTAGE CHARACTERISTICS OF SNS JUNCTIONS AND OTHER SUPERCONDUCTING WEAK LINKS. Waldram, J. R. (Cambridge Univ., Eng.); Pippard, A. B.; Clarke, J. Phil. Trans. Roy. Soc. London, Ser. A; 268: 265-87(19 Nov 1970).

A theory of the current–voltage characteristics of superconducting/normal/superconducting junctions is proposed. The theory is based on a simple model current–density equation. The form of the current–voltage characteristic is found to depend critically on whether the electrical source should be treated as a current source or a voltage source at high frequencies. A picture is given of the dynamic state of a junction at finite voltage, and all the important differences between the characteristics observed for SNS junctions and tunnel junctions are explained, at least qualitatively. In particular, the theory covers the cases of a junction wide enough to be limited by its own field and the step structure known to be induced by an applied hf field. For wide junctions the predicted behavior is an exactly calculable quantized flux flow in one dimension. It is the phase locking of this flux flow by the applied hf field that leads to the step structure. A detailed calculation of the rounding of the steps by noise is given; the steps are predicted to be exceedingly steep. The theory is compared with the theories of other superconducting weak links. (auth) (UK)

17088 INVESTIGATION OF THE MIXED STATE USING POLARIZED NEUTRONS. Pfeiffer, K.; Rauch, H.; Weber, H. W. (Oesterreichische Hochschule, Vienna). Phys. Lett.; 34A: 35-6 (25 Jan 1971).

Using the neutron depolarization technique, more elaborate measurements were taken on several niobium samples showing a characteristic dependence of the flux line lattice distortions on hysteresis. The depolarization maximum seems to indicate the entrance of the sample into the overall critical state. (auth)

17089 SUPERCONDUCTING CURRENT LOOP HAVING PREFERENTIAL CURRENT FLOW. Schweitzer, Donald G.; Adams, Peter D. (to United States Atomic Energy Commission). U. S. Patent 3,546,541. 8 Dec 1970. Filed 10 Jul 1968.

A superconducting current loop provided with strained and unstrained legs for producing preferential current flow in the strained leg is described. (auth)

17090 LOW-TEMPERATURE HEAT CAPACITIES OF THE CLATHRATE SALTS $Ag_7O_8NO_3$ AND $Ag_7O_8HF_2$. Conway, Mary M. (Univ. of California, Berkeley); Phillips, Norman E.; Gebelle, T. H.; Kuebler, N. A. J. Phys. Chem. Solids; 31: 2673-8(Dec 1970).

The heat capacities of $Ag_7O_8NO_3$ and $Ag_7O_8HF_2$ were measured between 0.3 and, respectively, 20 and 4°K. The measurements show that the previously reported type-II superconductivity is a bulk property, and give the values of some of the normal and superconducting-state parameters. There is a surprisingly strong dependence of the electronic density of states and Debye temperature on anion identity, but no convincing evidence for a direct effect of anion identity on T_c. (auth) (UK)

17091 INSTABILITIES BY THE FLUX JUMPS IN SUPERCONDUCTORS. Onishi, Toshitada. Denki Shikensho Iho; 34: 680-93(1970). (In Japanese).

Because of flux pinning by the structure defects, non-ideal type-II superconductors remain superconductive in fairly high critical fields and current densities. But the strong pinning forces sometimes become the causes of flux jumps, and therefore the current degradation may occur especially in the superconductors with the strong pinning force. Previous work on the flux-pinning mechanisms, the flux-jump characteristics and the current degradation of the coils is introduced, concluding that the current degradation is mainly due to the flux jumps and that the proper pinning center makes it possible to get the superconductors with the behavior $\partial J_c/\partial T > 0$. (auth)

17092 GEOMETRICAL DEPENDENCE OF THE MAXIMUM dc JOSEPHSON CURRENT. Stuehm, D. L.; Wilmsen, C. W. (Colorado State Univ., Fort Collins). J. Appl. Phys.; 42: 869-70(Feb 1971).

It is shown that the maximum Josephson current for a linear overlap junction is proportional to the width (for all widths) and nonlinearly related to the length of the junction. The experimental results of Pritchard and Schroen (J. Appl. Phys., 40: 2118 (1969)) are used along with theoretical reasons to show that the current is not proportional to perimeter or area. (M.H.R.)

17093 ENHANCED-MODE RADIATION DETECTION BY SUPERCONDUCTING FILMS. Bertin, C. L. (IBM Components Div., Hopewell Junction, N. Y.); Rose, K. J. Appl. Phys.; 42: 631-42(Feb 1971).

In the course of investigating radiant-energy detection by high-resistance superconducting films [≈10 KΩ/square (□)] an unexpected enhanced mode of detection was observed at microwave frequencies. This mode was observed in addition to, and differed significantly from, the expected thermal or bolometer mode of detection. Since that time detailed measurements were made of the dependence of the enhanced-mode response on bias current, incident power, temperature, and sample resistance; these are reported here. Correlation of the characteristics of the enhanced mode with the nonlinear VI (voltage–current) characteristics of the film is shown. This suggests that the enhanced mode is the result of a nonlinear response to currents induced in the film by the incident radiation, which explains the short wavelength cutoff associated with the enhanced mode. Physical mechanisms that might cause this response are considered, and fabrication techniques for these films are presented in detail. Since the initial report, enhanced-mode responses were observed with a responsivity per square ($r = 10^4$ V/W), which is thousands of times greater than the peak bolometer responsivity. At the operating point, the film has a lower output impedance [<50 Ω/square (□)] and responds with a time constant less than 0.1 nsec as estimated from heterodyning measurements at 9.4 GHz. At present, enhanced-mode devices with an active area of 1 cm^2 can achieve a noise equivalent power of less than 10^{-13} W $Hz^{-\frac{1}{2}}$. This compares quite favorably with other millimeter-wave detectors such as InSb free-carrier detectors, doped Ge detectors, and superconducting point-contact Josephson junction devices. (auth)

17094 SUPERHEATING, SUPERCOOLING, SURFACE SUPERCONDUCTIVITY, AND GINZBURG–LANDAU PARAMETERS OF PURE TYPE-I SUPERCONDUCTORS AND THEIR ALLOYS. Smith, F. W.; Baratoff, A.; Cardona, M. (Brown Univ., Providence). Phys. Kondens. Mater.; 12: 145-92(1970).

The low-frequency differential susceptibility of several pure type-I superconductors, viz. Sn, In, Tl, Pb and Hg, was measured as a function of increasing or decreasing applied magnetic fields. Special emphasis was placed on the observation of metastable (superheated and supercooled) states. Experimental values of the Ginzburg–Landau parameter κ at the transition temperature T_c and of suitably defined temperature-dependent parameters for superheating, $\kappa_{sh}(t)$, and for supercooling, $\kappa_{sc}(t)$, were obtained and compared with theoretical estimates. The rapid drop in κ_{sh} close to T_c observed in materials with $\kappa \ll 1$ such as Sn, In, and Tl is interpreted as a manifestation of nonlocal electrodynamics. Supercooling of the normal state down to the bulk nucleation field H_{c2}, rather than H_{c3}, was achieved close to T_c in Cu-plated samples of Sn and In. The parameters κ and $\kappa(t)$ were also determined for a series of SnIn alloys spanning the range between type I and type II behavior. Supercooling of the superconducting surface sheath below the thermodynamic critical field H_c was observed in these alloys as well as in pure Pb. The measured values of κ are

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compared with estimates based on normal-state parameters extracted from independent low-temperature experiments. Corrections for energy gap anisotropy and electron–phonon retardation are typically below 10%. The strong temperature dependence of $\varkappa_{sc}(t)$, observed in all the materials studied, is not explained by present theories, even in the concentrated alloys where anisotropy effects should be washed out. (auth)

17095 FLUCTUATION CONDUCTIVITY OF TUNNEL JUNCTIONS. Cheishvili, O. D. (Physics Inst., Tbilisi, USSR). JETP Lett. (USSR) (Engl. Transl.); 12: 279-81(20 Oct 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 404-6 (20 Oct 1970).

A theoretical investigation was made of the influence of fluctuations on the tunnel current in MIM and SIM junctions for temperatures above the critical temperature. Retarded Green's function equations are derived. The results show that, for MIM junctions, the fluctuation term becomes appreciable for contaminated metals when $(T - T_c)/T \sim 10^{-2}$. For SIM junctions, the fluctuation correction to the current is negligible for applied potentials less than Δ. (D.L.C.)

17096 DETERMINATION OF THE FORBIDDEN BAND OF Sn–Pb DOUBLE LAYERS AS A FUNCTION OF TEMPERATURE. Romagnan, Jean-Pierre (Univ., Nice); Gilabert, Alain; Guyon, Etienne. Compt. Rend., Ser. B; 271: 597-9(28 Sep 1970). (In French).

The forbidden band of a superconducting Sn(N)/Pb(S) system is calculated using the MacMillan model, which assumes that the electron excitations involved in the tunnel effect essentially move perpendicularly to the (N) film. A continuous variation in the forbidden band gap with respect to temperature is predicted on both sides of the Sn critical temperature point, in agreement with the experimental results. (France)

17097 ELECTROMAGNETIC RESPONSE OF SURFACE SUPERCONDUCTING SHEATH IN AN INCLINED MAGNETIC FIELD. Maki, Kazumi (Faculte des Sciences, Orsay, France). J. Low Temp. Phys.; 3: 545-58(Nov 1970).

The microwave response of the superconducting surface sheath in an inclined magnetic field is studied theoretically. Due to the vortex structure in the surface sheath in the present configuration, the low-frequency electromagnetic response is dominated by the flux-flow mechanism. Limiting the study to the dirty limit, the surface impedance is calculated explicitly. It is found in particular, that the surface resistance has a sharp minimum at $\theta = 0$, where θ is the angle between the dc magnetic field and the sample surface. (auth)

17098 STABILITY OF SUPERCURRENTS IN CYLINDRICAL FILMS OF TIN. Meissner, Hans (Stevens Inst. of Tech., Hoboken, N. J.). J. Low Temp. Phys.; 3: 563-76(Nov 1970).

Using pulsed currents of 80-nsec duration, the stability of supercurrents in cylindrical films with current return through the center was investigated. It is found that the voltage along the film rises with time t approximately as $V = a\{1 - \mathrm{erf}[t'/2(t - c)],\}$ where the time constant t' is an exponentially decreasing function of $i(1 + 420/d)/[1 - (T/T_c)^4]$. Here i is the current through the sample, d the thickness of the film in angstroms, and T/T_c the reduced temperature. Comparison with older data by Mydosh and Meissner and by Hagedorn indicates that it is indeed the current i, rather than the current density J, that determines t'. It is suggested that the instability is of the nature of those investigated by Kramer and by Fink and Presson for currents in a superconducting surface sheath. (auth)

17099 STUDY OF THE LEAD–INDIUM ALLOY SYSTEM BY ELECTRON TUNNELING TECHNIQUES. Jackson, Jerome Edward. Cleveland; Case Western Reserve Univ. (1969). 109p. University Microfilms Order No. 70-25,965.

Thesis.

Electron-tunneling techniques were used to study some properties of the superconducting lead–indium alloy system. The dynamic conductance of tunnel junctions having the form, Al/Al oxide/PbIn, provide information on the lattice vibrations of the alloy system. The spectrum of frequencies change as the light indium impurity is added. A band of frequencies first appears at frequencies above and isolated from the main lead frequency band. At higher concentrations the impurity band merges into the main band and forms a new spectrum that gradually resembles the pure indium spectrum as the concentration is increased. A determination of the energy gap to superconducting transition temperature ratios, $2\Delta_0/kTc$, indicate that the electron–phonon interaction remains constant up to high impurity concentrations. This interaction, which is responsible for superconductivity, is seen to depend on the low-frequency dependence of the lattice vibrations. (Diss. Abstr. Int., B)

17100 MICROWAVE AND FLUCTUATION RESISTANCE OF SUPERCONDUCTING ALLOY FILMS. Thompson, Richard S. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., B; 3: 1617-24(1 Mar 1971).

The microwave resistance of dirty superconducting films with magnetic fields just less than the critical values applied parallel to their surfaces has been calculated, together with the paraconductivity due to fluctuations just above the critical fields. Maki's results for the microwave resistance of the surface sheath are corrected and extended to include films of all thicknesses. Singularities similar to those observed in tunneling measurements are predicted to occur at the critical thickness for flux entry. Anisotropies for different relative orientations of the electric and magnetic fields are predicted, which are at a maximum at the flux entry and vanish only in the thin-film limit. (auth)

17101 LINEAR RESPONSE THEORY AND THE TIME-DEPENDENT GINZBURG–LANDAU EQUATIONS. Houghton, A.; Maki, K. (Faculte des Sciences, Orsay, France). Phys. Rev., B; 3: 1625-30(1 Mar 1971).

The transport properties associated with vortex motion in type-II superconductors are reformulated in terms of linear response theory (LRT). In particular, in the dirty limit, a simple relation is established between LRT and the time-dependent Ginzburg–Landau equation. In the more general case of a type-II superconductor with arbitrary electronic mean free path, the expressions for the transport coefficients are presented in terms of retarded products. These expressions will be particularly useful in determining the transport properties of clean type-II superconductors. (auth)

17102 COMMENTS ON THE UPPER CRITICAL FIELD OF TYPE-II TWO-BAND SUPERCONDUCTORS. Chow, W. S. (Univ. of Cincinnati). Phys. Rev., B; 3: 1773-5(1 Mar 1971).

The justification for the existence of interband coupling between the pair wave functions Δ_s^* and Δ_d^* for two-band superconductors in the dirty limit is explained in greater detail. (auth)

17103 ABSENCE OF QUANTUM-ELECTRODYNAMIC CORRECTIONS TO THE CHARGE OF THE ELECTRON AS MEASURED IN JOSEPHSON JUNCTION EXPERIMENTS. Hartle, J. B.; Scalapino, D. J.; Sugar, R. L. (Univ. of California, Santa Barbara). Phys. Rev., B; 3: 1778-81(1 Mar 1971).

The ac Josephson effect enables one to measure the ratio $\Delta\mu/h$, where $\Delta\mu$ is the electrochemical potential difference between two weakly coupled superconductors. Combined with an independent measurement of the electrostatic potential difference V, this measurement determines the ratio e/h. This determination rests on the fact that a voltage difference is defined so that the electrochemical potential difference is $\Delta\mu = eV$, where e is the charge on the free electron. Further, while it is argued that it is not directly relevant to the determination of e/h, there are no quantum-electrodynamic corrections to the electrostatic term in the chemical potential difference $\Delta\mu$. (auth)

17104 STATISTICAL MECHANICS OF THE ELECTRON–PHONON SYSTEM. Gallavotti, G. (Univ., Rome); Ginibre, J.; Velo, G. Lett. Nuovo Cim.; 4: 1293-7(26 Dec 1970).

The electron–phonon system has received considerable attention in connection with the phenomenon of superconductivity, where the condensation of electron pairs is believed to arise from the attraction produced by the phonons. The system is usually described by the Froehlich Hamiltonian, where the phonons are represented by a scalar field linearly coupled to the electron density. Although this interaction has been widely used for approximate calculations, it has never been proved that it provides a statistical-mechanical description in the usual sense, in particular that it allows the infinite-volume limit to be taken for the thermodynamic quantities. This problem is considered here, concentrating on the statistical mechanics of the electrons. Therefore, the Feynman method is used, in which the statistical operator of the electrons is given by a path integral representation and the phonon field is eliminated at the expense of introducing a noninstantaneous interaction between the electrons. Except for this last feature, the situation is then similar to the one encountered in the case of quantum systems with instantaneous potentials. Some of the results obtained in the latter case are extended to the present one. (M.H.R.)

17105 UPPER CRITICAL MAGNETIC FIELD OF LEAD AS FUNCTION OF MEAN FREE PATH OF THE ELECTRONS. Koepke, R.; Bergmann, G. (Univ., Goettingen, Ger.). Z. Phys.; 242: 31-44(1971).

The transition curves of quenched lead films are measured in a perpendicular magnetic field as a function of the field strength. The mean free path of the electrons is varied by different condensation temperatures and by the annealing of the films. An in-

fluence of the edge of the film on the resistance measurement is suppressed by the superposition of iron onto the lead film. It is shown that the measured critical field $B_{c\perp}$ of the film is the upper critical field B_{c2} of a bulk superconductor with the same effective mean free path. As a result of the measurements $\partial B_{c2}/\partial T$ is obtained as a function of the degree of disorder (the mean free path of the electrons) of the films. The results are compared with the theory of Gor'kov for the weak-coupling superconductor and the theory of Eilenberger and Ambegaokar for the strong-coupling superconductor. They disagree with both theories. From the magnetic measurement the coherence length of lead may be determined. An independent determination at the same film is given by the proximity effect of the system Pb/Fe. The results of both methods are compared. (auth)

17106 NONLINEAR EFFECTS IN THE ELECTRODYNAMICS OF SUPERCONDUCTORS IN A VARIABLE FIELD. Fedorov, M. A. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 59: 1716-32(Nov 1970). (In Russian).

Nonlinear effects in superconductors located in an electromagnetic field, which is the sum of a stationary and variable fields of frequency $\omega \ll \Delta$, are studied. It is shown that, even for $l \gg \xi_0$ in nonlinear nonequilibrium problems, impurities should be taken into account. The behavior of the gap and nonlinear surface impedance is found to depend on the parameter $\lambda = (\tau\sqrt{(2\Delta\omega)})^{-1}$. The coordinate dependence of the gap harmonic of frequency ω and the nonlinear correction to the surface impedance are calculated. It is shown that oscillations of the gap lead to a change in sign of the nonlinear correction to the impedance on transition through the frequency $\omega \sim \Delta^2/T_c$. (auth)

17107 EXCITATION STATE DENSITY IN THIN SUPERCONDUCTING FILMS LOCATED IN A MAGNETIC FIELD. Isaakyan, A. R.; Ovchinnikov, Yu. N. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 59: 1846-53(Nov 1970). (In Russian).

An expression is obtained for the excitation state density in thin pure films located in a magnetic field satisfying the condition $eHd^2 \ll 1$ (d is the film thickness). The effect of impurities on the spectrum of thin current-carrying films during specular electron reflection by the boundary is investigated. (auth)

17108 SUPERCONDUCTOR ENERGY GAPS FROM TUNNELING. Pike, G. E. (Sandia Labs., Albuquerque, N. Mex.). J. Appl. Phys.; 42: 883-4(Feb 1971).

When only one side of the tunnel junction is superconducting, there is no sharp increase in the current comparable to that when both sides are superconducting and, hence, it is difficult to identify features of the junction characteristic with the superconducting energy gap. To alleviate this difficulty, the relation between the energy gap and the junction bias voltage at which the differential conductance is a maximum is numerically computed. (M.H.R.)

17109 SUPERCONDUCTIVITY OF DISORDERED FILMS OF Hg CONTAINING $HgBr_2$ OR $HgCl_2$ ADDITIONS. Buck, V.; Hilsch, R.; Korn, D. (Univ., Goettingen, Ger.). Z. Phys.; 242: 1-11 (1971). (In German).

Mercury films were condensed with admixtures of $HgBr_2$ or $HgCl_2$ onto a substrate at 4.2°K. The superconducting transition temperature was measured as a function of the impurity concentration. The transition temperature increases from 3.96°K of the pure quenched film to 4.06°K at a content of 0.3 mol.% $HgBr_2$. Higher impurity concentrations lower the transition temperature and superconductivity vanishes at about 16 mol.% $HgBr_2$ or 23 mol.% $HgCl_2$, respectively. Above these concentrations the electrical resistivity shows a negative temperature coefficient. By means of Debye–Scherrer diagrams a diminishing of the crystallite size with increasing impurity concentration is found. (auth)

17110 NORMAL PRECIPITATES IN TYPE-II SUPERCONDUCTING EUTECTIC ALLOYS. Goodfellow, J. E.; Rhodes, R. G. (Univ. of Warwick, Eng.). J. Phys., D (London); 3: 1830-6(Dec 1970).

The effect of a second phase on the sheath current-carrying capacity of type-II superconductors is investigated by measurements on suitable binary eutectic alloys. The results show that the presence of a normal second phase increases the sheath current. Furthermore, the orientation of the second phase with respect to the applied field is shown to affect the value of the sheath current. The results are explained by postulating surface sheath superconductivity occurring at the interfaces of the superconducting matrix with the second phase. (auth) (UK)

17111 SCHOTTKY BARRIER PROBE TUNNELING INTO SUPERCONDUCTORS. Thompson, W. A.; von Molnar, S. (IBM Thomas J. Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys.; 41: 5218-23(Dec 1970).

Some GaAs probe tunneling experiments are described that exhibit the usefulness and reliability of this bulk tunneling method. Tunneling characteristics were observed for all superconducting counter-electrodes, and the measured ratios of superconducting energy gap to transition temperature were in good agreement with measurements by other techniques. Also described are the effects of contact pressure and a novel in situ surface cleaning technique for removing chemically contaminated surface layers. (auth)

17112 MAGNETIC SUSCEPTIBILITY OF TRANSITION-METAL A15-TYPE PHASES. Bardos, D. I. (Argonne National Lab., Ill.); Waterstrat, R. M.; Rowland, T. J.; Darby, J. B. Jr. J. Low Temp. Phys.; 3: 509-18(Nov 1970).

The temperature dependence of the paramagnetic susceptibility was measured for several binary A15-type compounds of transition elements. Measurements were made between room temperature and either 3°K or the superconducting transition temperature, whichever was higher. The susceptibilities were found to have, in most cases, a small linear temperature dependence. Molar susceptibilities χ_M, superconducting transition temperatures T_c, and electronic specific heat coefficients γ for these compounds, when plotted as a function of the valence-electron concentration e/a, reveal peaks at an e/a of about 6.5 for all three properties. Compounds containing the 4d-series transition elements molybdenum or niobium have higher T_c and lower χ_M values than compounds containing the 3d transition-element chromium or vanadium. It appears that an increased mixing of atoms on either of the two crystallographic sites in the A15-type structure can be associated with a significant decrease in the paramagnetic susceptibility of the compound. (auth)

17113 EFFECT OF NONMAGNETIC 4f RESONANCES ON THE SUPERCONDUCTING TRANSITION TEMPERATURE: ThCe ALLOYS. Huber, J. G.; Maple, M. B. (Univ. of California, San Diego, La Jolla). J. Low Temp. Phys.; 3: 537-44(Nov 1970).

It is shown that a recent theory due to Kaiser concerning the effect of nonmagnetic resonant states on superconductivity appropriately and accurately, describes the dependence of the transition temperature T_c of Th–Ce alloys on Ce concentration. The parameters describing the f-resonant states in the Anderson model are determined by fitting Kaiser's theory to the data, and reasonable values are obtained. With the assumption that the Hartree–Fock level width remains constant under pressure, it is shown that the f level moves further above the Fermi level as the pressure is increased. This is discussed in relation to recent pressure experiments on La and La compounds containing Ce impurities. (auth)

Equipment and Devices

17114 (MIT–3700-13) CONSIDERATION OF THE THERMAL PROPERTIES OF MATERIALS IN THE DESIGN OF TRANSIENTLY STABLE SUPERCONDUCTING MAGNETS. Hale, J. R. (Massachusetts Inst. of Tech., Cambridge. Francis Bitter National Magnet Lab.). [nd]. Contract AT(30-1)-3700. 23p. Dep. NTIS.

A method of analyzing the transient thermal behavior of a section of magnet winding using a computerized model was described previously. The previous study is extended here to include a number of interleaving materials, the use of both copper and silver as the normal metal component of the conductor, and the use of thin, inorganic insulation. (M.H.R.)

17115 (ORO–3665-24) SELF-CONSISTENT THRESHOLD CALCULATIONS FOR THE SUPERCONDUCTING INJECTION LASER. Bostock, J.; Gregory, W. D.; Leopold, L.; Mathews, W. N. Jr. (Georgetown Univ., Washington, D. C.). Sep 1970. 247p. Dep. NTIS.

The basic physical picture of the superconducting injection laser and the results of a temperature-dependent threshold current density calculation for tantalum are reviewed. A self-consistent procedure for determining the threshold conditions for lasing was devised and is explained in detail. To apply this procedure to real materials, a method of determining the effective interaction parameter of a superconductor (which is used to obtain the value of the energy gap) has been developed. Results of the calculations for the interaction parameter and the self-consistent lasing conditions are presented for tantalum, aluminum, vanadium, and lead. Parameter-type calculations, which determine the effects of large current injection on the magnitude of the energy gap, are carried out for the above materials in both the weak- and strong-injection limits (depairing due to excessive drift velocities and depairing due to both drift velocity and overpopulation of quasi-particle

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levels, respectively). These results clearly delineate for both limits those current densities that significantly reduce the energy gap and those that cause the energy gap to disappear entirely. (auth)

17116 MAGNETIC INSERTS TO IMPROVE FIELD HOMOGENEITY IN A SIMPLE SUPERCONDUCTING SOLENOID. Templeton, I. M. (National Research Council of Canada, Ottawa). J. Phys., E (London); 3: 994-6(Dec 1970).

Tubular inserts of magnetic material may be used to improve the local field homogeneity in a simple (uncorrected) superconducting solenoid. Approximate calculations and measured performance show that, for a limited field range, improvements of over 40 times may be achieved in a volume of a few cubic millimeters. (auth) (UK)

Plasma and Thermonuclear Physics

Refer also to abstracts 16875 and 17351.

17117 (NP-18496) ANNUAL REPORT, 1969. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 197p. (In German). Dep. NTIS (U. S. Sales Only).

Brief discussions of research during this period are given for the following: (1) Isar devices, (2) plasma heating by shock waves, (3) measuring methods in hot plasmas, (4) stationary heating of dense plasmas, (5) plasma production by laser beams, (6) MHD generators, (7) surface physics, (8) relativistic plasmas, (9) kinetic theory of plasma, and (10) various engineering developments. (M.O.W.)

17118 (UCRL-50002-70) CONTROLLED THERMONUCLEAR RESEARCH. Annual Report, July 1969-June 1970. (California Univ., Livermore. Lawrence Radiation Lab.). 21 Jul 1970. 208p. Dep. NTIS.

Separate abstracts were prepared for the six included sections. (M.O.W.)

For abstracts of individual sections see: 17124, 17136, 17168, and 17209-17211.

17119 PLASMA PHYSICS INDEX. VOLUME 5, NO. 11, 1970. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 127p.

This listing includes 618 articles on various aspects of plasma physics. (M.O.W.)

17120 PLASMA PHYSICS INDEX. VOLUME 5, NO. 12, 1970. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 86p.

This listing includes 397 articles on various aspects of plasma physics. (M.O.W.)

Confinement and Heating

Refer also to abstract 17191.

17121 (AD-713064) CONFINEMENT OF LASER-PRODUCED PLASMA IN RESONANT CAVITIES BY RF ELECTROMAGNETIC FIELDS. Final Report. Dean, Stephen O. (Naval Research Lab., Washington, D. C.). 28 Sep 1970. 20p. (NRL-7136). NTIS.

The use of rf electromagnetic fields to confine dense high-temperature plasma has been considered "unpromising" because of the high electric fields required (greater than one million V/cm) and primarily because the ohmic energy losses in normal-conducting cavity walls are huge in comparison to all other energies involved, including possible thermonuclear yields. The very high fields required are today within reach. The advent of superconducting cavities with Q's exceeding 10 billion reduces ohmic wall losses to a negligible value (approximately 1/100) of thermonuclear yield. Two other problems arise, however: (a) what are the effects of rf interactions with the plasma sheath, and (b) is it possible to maintain a superconducting surface in the presence of plasma bremsstrahlung. Inadequate information exists with which to draw firm conclusions on whether or not these problems preclude the possibility of an rf-confined thermonuclear reactor. Many of the physics questions may possibly be studied in a laser-produced plasma experiment, such as the one described. (auth) (USGRDR)

17122 (CLM-R-105) SINGLE PARTICLE MOTION IN AXISYMMETRIC SYSTEMS HAVING A TOROIDAL ELECTRIC FIELD. Gibson, A.; Wilson, C. M. (Texas Univ., Austin. Center for Plasma Physics and Thermonuclear Research. United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Jul 1970. 6p. Dep. NTIS (U. S. Sales Only). UK 1s. 2d.

Guiding-center computations confirm that a parallel electric field gives rise to an enhanced radial drift of blocked particles. The computations also show that the electric field can "unblock" the particles and so terminate the drift. (auth)

17123 (CTO-740) THE INFLUENCE OF THE RESONANCE STRUCTURE OF THE MAGNETIC FIELD ON THE CONTAINMENT OF COLLISIONLESS PLASMA IN THE TOR-1 STELLARATOR. Andryukhina, E. D.; Soldatskii, I. A.; Fedyanin, O. I.; Khol'nov, Yu. V. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated by J. B. Sykes (Culham Lab., Abingdon, Eng.), from report NP-18470. 11p. Dep. NTIS (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 24: 51606.

17124 (UCRL-50002-70, pp 4,1-17) TOROIDAL CONFINEMENT PROGRAM. (California Univ., Livermore. Lawrence Radiation Lab.).

From Controlled thermonuclear research.

Brief summaries of research are given for the following: (1) Levitron experimental results, (2) superconducting Levitron, (3) numerical studies of toroidal magnetic fields, (4) Hybritron experiment, and (5) stabilized pinch in relativistic electrons. (M.O.W.)

17125 (UCRL-50976) ASSESSMENT OF NEUTRAL INJECTION FOR THE SUPERCONDUCTING LEVITRON. Hartman, C. W.; Hooper, E. B. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). 19 Nov 1970. 14p. Dep. NTIS.

Analysis of the plasma obtainable by neutral injection into the superconducting levitron is presented. Existing sources (multi-apertured test sources) can yield hydrogen plasmas with $n \approx 10^{13}$ cm^{-3} and $T_e = T_i > 0.3$ keV; presently contemplated sources would yield $n = 10^{14}$ cm^{-3} and $T_e = T_i \gtrsim 1$ keV. The limitations imposed by cold background gas are considered, and engineering problems are discussed briefly. (auth)

17126 CYCLOTRON RADIATION FROM THE PLASMA WITH LOSS-CONE DISTRIBUTION. Kako, Masashi (Nagoya Univ., Japan). Kakuyugo Kenkyu; 24: 233-40(Jan 1970). (In Japanese).

The radiation loss of plasma in a mirror field was theoretically examined according to the method of Trubnikov-Kudryavtsev. The plasma was divided into disk layers perpendicular to the field, and the velocity distribution in each disk was assumed to be isotropic Maxwell distribution with loss-cone cut. The expressions were obtained for the absorption coefficient and the emissivity for the radiation perpendicular to the field. The mirror field was assumed to be a harmonic function of the position, and the loss due to cyclotron radiation was evaluated for each disk. Near the end of the mirror field, the loss increases due to the increased magnetic field. It decreases rapidly at the end due to the decrease of particle density. The radius of the plasma column required for the energy balance is discussed. $\omega_p^2 < \omega_c^2$ was assumed throughout. (Japan)

17127 CONFINEMENT PROPERTIES OF THE LEVITATED SPHERATOR. Freeman, R.; Johnson, L.; Okabayashi, M.; (and others) (Princeton Univ., N. J.). Phys. Rev. Lett.; 26: 356-60(15 Feb 1971).

To eliminate the anomalous loss due to convective cells produced by the existence of the supports in the plasma volume, a levitated superconducting ring was installed in the Princeton spherator. The plasma decay time is increased from 10 to 15 msec in the supported version to a maximum of 150 to 220 msec for a helium discharge plasma. At $n_e = 2 \times 10^{11}$ cm^{-3} and $T_e =$ 1 to 2 eV, this decay time is $\frac{1}{2}$ to $\frac{1}{4}$ of the calculated density decay time due to the classical diffusion process. (auth)

17128 ROLE OF END REGIONS IN THE STEADY STATE OF MIRROR-CONFINED PLASMAS. Guillory, John U. Jr.; Kunkel, Wulf B. (Univ. of California, Berkeley). Plasma Phys.; 12: 529-43(Jul 1970).

In open-ended plasma confinement at reasonable ion temperatures and relatively high densities (such as 10 keV and 10^{13} cm^{-3}, or 100 eV and 10^{16} cm^{-3}) the Coulomb-scattering loss flux alone gives rise to a charged-particle density outside the mirrors that is usually large enough to require quasi-neutrality there. Such confinement must therefore be considered as involving an external plasma even in the absence of ionization or other plasma sources in this external region. Some of the effects of this plasma on the steady-state features of mirror confinement were investigated. In particular, it was found that a significant electrostatic potential must usually exist between a mirror and any external boundary (though its magnitude can be reduced by plasma sources outside the mirrors). It follows that some energetic electrons will have

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turning points well outside the mirrors and yet remain trapped. Any external plasma source will cause additional electrons to stream through the confinement region. An estimate was made of the change in steady-state confinement parameters due to this streaming, in the limit of negligible unstable interaction with the confined plasma and some trapping of the streaming electrons. The effect of these properties of open-ended confinement on various instabilities has not yet been fully explored. (auth) (UK)

17129 THEORY OF SIMULATOR EXPERIMENTS ON ELECTRON DIFFUSION IN MAGNETIC-MIRROR TRAPS. Skuridin, G. A.; Chesalin, L. S. Cosmic Res. (USSR) (Engl. Transl.); 8: 90-5(Jan-Feb 1970).

Translated from Kosm. Issled.; 8: 98-103(Jan-Feb 1970).

The diffusion of electrons in a trap with magnetic mirrors under the action of perturbing pulses with a specific shape is investigated by means of numerical methods. A brief description of the experiments is given. The unperturbed field in the Probkotron ("stoppertron") was axially symmetric. The characteristic rise time of the axially nonsymmetric perturbation up to its maximum was equal to its decay time and was somewhat shorter than the electron-drift revolution period. Although the Larmor radius (~1.5 cm) was comparable to the dimension of the operating trap section (~9 cm), the drift equations were integrated numerically for determining the diffusion coefficients. The Fokker–Planck equation with the coefficients thus determined was solved numerically by means of a computer. In spite of the limited applicability of the drift approximation in this case, the theoretical results are in satisfactory agreement with experimental data, which would indicate that the method used in developing the theory was correct. (auth)

17130 ELECTROMAGNETIC PENETRATION AND CONFINEMENT OF A HOT DENSE PLASMA. Hall, Richard B.; Gerwin, Richard A. (Boeing Scientific Research Labs., Seattle). Phys. Rev., A; 3: 1151-61(Mar 1971).

For a special model, it is possible to compute the self-consistent confinement and penetration of an energetic plasma by an rf field of large amplitude for arbitrary values of the quantity $(v/c)(\omega_p/\omega)$, where v is a characteristic electron thermal speed, ω_p is the plasma frequency deep in the plasma, and ω ($<\omega_p$) is the rf frequency. Previous theories concerning nonlinear behavior of electromagnetic waves in plasmas have required this quantity to be small compared to unity. (auth)

17131 PARAMETER STUDIES FOR TOKAMAKS AND DOUBLETS. Ohkawa, Tihiro; Jensen, Torkil H. (Gulf General Atomic Inc., San Diego, Calif.). Plasma Phys.; 12: 789-97(Oct 1970).

Tokamak and Doublet are schemes for confinement and ohmic heating of plasma. A number of scaling laws for these devices are discussed. These scaling laws stem from requirements that the plasma be stable against a number of instabilities or that the energy balance must be positive, i.e., the energy input due to ohmic heating must exceed energy losses due to impurity radiation, heat conduction, etc. The scaling laws are found compatible with the experimental results from Tokamak-3. It is found that a higher value of β may be obtained in Doublets than in Tokamaks. (auth) (UK)

17132 COLLECTIVE INTERACTIONS AND PLASMA HEATING IN A HIGH-CURRENT GAS DISCHARGE. Suprunenko, V. A.; Sukhomlin, E. A.; Tolok, V. T. (Physical-Tech. Inst., Kharkov). Plasma Phys.; 12: 627-37(Aug 1970).

The results are presented of an experimental investigation of processes involved in the development of kinetic instabilities and the heating of a dense plasma in a strong electric field. It is shown that, in a high-current gas discharge, effective heating of both the electron and ion components of the plasma occurs, associated with an anomalous plasma resistivity and intense microwave emission from the plasma at frequencies considerably below the plasma frequency due to the development of high-frequency instabilities. The results are discussed and an explanation offered for the mechanism responsible for the development of the instabilities. (auth) (UK)

17133 USE OF A STIX COIL FOR ION CYCLOTRON RESONANCE HEATING IN A NON-UNIFORM MAGNETIC FIELD. Sinclair, R. M.; Rothman, M. A.; Hosea, J. C. (Princeton Univ., N. J.). Plasma Phys.; 12: 639-41(Aug 1970).

The confining field of a Model C stellarator was modified so as to produce an approximately linear variation of confining field along the length of the coil. By so modifying the field, it was hoped to be able to couple appreciable power over a wider range of plasma densities than before. Broadening the density range over which significant coupling occurs would then perhaps allow one to inject more energy into the plasma. It was found that variation of the magnetic field along the ion-cyclotron-resonance heating induction coil lead to a somewhat-lessened dependence of the resistance offered the rf supply by the coil, on plasma density at low power levels, but lead to no improvement in the overall heating of the plasma at high power levels. These results do show that it will be possible to use ion-cyclotron-resonance heating via inductive coupling, even if at reduced efficiencies, in devices in which the magnetic field is inherently nonuniform. (UK)

Diagnostics

17134 (AD–713104) SOLENOIDS EXCITED AT RADIO FREQUENCIES IN THE PRESENCE OF PLASMAS. Final Report, September 1967–December 1969. Sprouse, J. A. (Arnold Engineering Development Center, Arnold Air Force Station, Tenn. ARO, Inc., Arnold Air Force Station, Tenn.). Oct 1970. Contract F40600-71-C-0002. 31p. (AEDC-TR–70-206; ARO-ETF-TR–70-184). NTIS.

The rf-excited coil in the presence of a plasma is examined in terms of a transformer model and also in terms of the distortion of the electromagnetic fields which is produced by the induced eddy currents in the plasma. The treatment of rf coils presented here can be applied to either the plasma diagnostics regime or to the generation of the rf electrodeless discharge. Although the calculations of the electric and magnetic fields are for a cylindrically symmetric coil immersed in a uniform, linear plasma, neither the model nor the approach to the problem is limited to these cases. (auth) (USGRDR)

17135 (ORNL-TM–3302) ELECTRON DISTRIBUTION MEASUREMENTS IN A HOT ELECTRON, MIRROR CONTAINED PLASMA. Ard, W. B.; Hogan, W. A.; Stetson, R. F. (Oak Ridge National Lab., Tenn.). Feb 1971. 16p. Dep. NTIS.

Electron distributions in the afterglow of a hot-electron, mirror-contained plasma are measured as a function of time by analysis of the bremsstrahlung spectra. The distributions are compared to those derived from a computer model which follows the cooling and scattering of electrons by ions and neutral molecules. It is found that, although scattering of neutrals is an important process in cooling the electrons in this plasma, the major loss mechanism is scattering into the loss cone. (auth)

17136 (UCRL–50002-70, pp 5.1-15) PLASMA AND ATOMIC RESEARCH. (California Univ., Livermore. Lawrence Radiation Lab.).

From Controlled thermonuclear research.

Brief discussions of research are given for the following: (1) development of laser plasmas, (2) laser scattering by sheet-pinch plasmas, (3) spectroscopic techniques for measuring hf electric fields in plasmas, (4) facility for studying steady-state plasmas, (5) feedback stabilization of a hollow-cathode discharge plasma, and (6) atomic and molecular collisions. (M.O.W.)

17137 (UCRL–50983) AN EXPERIMENTAL EVALUATION OF A PULSED, SUBMILLIMETER LASER INTERFEROMETER FOR TRANSIENT PLASMA DIAGNOSTICS. Throop, Alan L. (California Univ., Livermore. Lawrence Radiation Lab.). 10 Dec 1970. 14p. Dep. NTIS.

The application of a far-infrared interferometer to transient plasma diagnostics is described. The experimental performance of the interferometer under varying plasma conditions is presented. Detailed discussion is devoted to such important system parameters as observable density range, spatial resolution, time response, calibration techniques, and gamma radiation effects. (auth)

17138 SUPERSONIC FLOW OF A RAREFIED PLASMA AROUND TWO-DIMENSIONAL BODIES. Gurevich, A. V.; Smirnova, V. V. (Lebedev Inst. of Physics, Moscow. Physical-Technical Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 313-17(1970).

Translated from Geomagn. Aeron.; 10: 402-7(1970).

The supersonic flow of a rarefied plasma around a slab is analyzed. Allowance is made for the influence of the electric field on ion motion. The results of numerical computations are presented. (auth)

17139 CONTINUUM THEORY OF SPHERICAL ELECTROSTATIC PROBES (FROZEN CHEMISTRY). Bush, William B. (Univ. of Southern California, Los Angeles); Fendell, Francis E. J. Plasma Phys.; 4: 317-34(May 1970).

Electrostatic probes are well known as measuring devices in low-density plasmas. In this article, attention is confined to their more recent use in high-density, slightly ionized gases, describable by a continuum model. The steady-state anslysis of a spherical

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probe in an unbounded, quiescent, chemically frozen plasma is examined—forced convection, recombination–ionization, and magnetic field effects are taken as absent. (auth) (UK)

17140 PLASMA DIAGNOSTICS. Knott, R. G. A. (North Staffordshire Polytechnic, Stoke-on-Trent, Eng.). Contemp. Phys.; 12: 57-74(Jan 1971).

The more important techniques being used for measurements on laboratory plasmas are described. High-temperature plasmas are extremely difficult to contain for times of only a few milliseconds. Consequently, it is essential for any successful technique to be able to provide adequate resolution in time so that the mechanisms controlling the growth and decay of the plasma may be understood. (auth) (UK)

17141 METHOD OF AND APPARATUS FOR MEASURING THE DEGREE OF CIRCULAR POLARISATION PRODUCED BY A TRANSPARENT BODY. (to Compagnie Generale d'Electricite). British Patent 1,219,667. 20 Jan 1971. Priority date 4 Jul 1967, France.

The method described is applicable to the determination of electron density of a plasma by measuring the degree of circular polarization caused by the electrons of the plasma. The plasma to be tested is placed inside a laser cavity. (M.O.W.)

17142 MEASUREMENTS IN PLASMA DIAGNOSTICS USING MACH–ZEHNDER INTERFEROMETER. Exner, Vaclav Ladislav (Inst. of Physics, Prague). Cesk. Cas. Fys.; 20: 396-412(1970). (In Czech).

The principle of the optical-interference method is described, and formulas for determining the value of the interference fringe shift are derived. Dispersion equations stating the relation between the refractive index n and the gas density ρ, the free-electron concentration N_e, and the product of the concentration of excited atoms in the state i and the respective strength of the oscillator $N_i f_{ik}$ are presented. A Mach–Zehnder interferometer is the most frequently used apparatus for the interference measurements of these quantities. The interferometer with a crossed spectrograph using white light according to Rozhdestvenski is described. Less-known methods to obtain and evaluate the interferograms are discussed. A considerable part of the paper concerns the concrete applications of optical interferometry in general and the Mach–Zehnder interferometer in particular for plasma diagnostics. (auth)

17143 PROPAGATION OF LONGITUDINAL ELECTRON CYCLOTRON HARMONIC PLASMA WAVES IN A FINITE PLASMA COLUMN. Clinckemaillie, A. (Institut fuer Plasmaphysik, Garching, Ger.). pp 243-70 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

The propagation of electron cyclotron plasma waves for diagnostic purposes is discussed. An experimental apparatus employing this technique is described along with the measured results. (M.O.W.)

17144 COLLISION MEASUREMENTS BY MAGNETOPLASMA PULSE RESPONSE. Bruce, R. L.; Larsen, J. M. (Stanford Univ., Calif.). J. Appl. Phys.; 42: 895-6(Feb 1971).

The electron velocity induced by an applied rf pulse was calculated from measurements of the pulse shape and peak power. The maximum obtainable velocity was found to be 1.8×10^8 cm/sec and was limited only by the power available from the pulse amplifier. Control of the electron velocity was achieved by reduction of the applied rf pulse power with a calibrated variable attenuator. The total velocity error is estimated as 15%. (M.O.W.)

17145 ABSORPTION OF INFRARED RADIATION AS A GENERAL TECHNIQUE FOR THE DETERMINATION OF PLASMA TEMPERATURE. Wheeler, C. B.; Fielding, S. J. (Imperial Coll. of Science and Tech., London). Plasma Phys.; 12: 551-64 (Aug 1970).

It is shown that the continuum absorption coefficient K(λ) of a plasma at temperature T and electron density N_- for radiation of wavelength λ has the dependence $K(\lambda) \propto \bar{z}\lambda^2 N_-^2 T^{-\frac{1}{2}}$. The temperature here is the free electron temperature and $\bar{z}$ is the average ionic charge in the plasma. Recent techniques of laser interferometry enable N_- to be measured to 2% and therefore it is proposed that an infrared absorption measurement could enable T to be assessed to better than 7% for plasmas of known N_- and $\bar{z}$. Full calculations of K(λ) are given for radiations of 3.39- and 10.6-μ wavelength, corresponding to the prominent transitions of the helium–neon and carbon dioxide lasers, respectively. The outstanding features of this proposed technique of temperature measurement are that plasma local thermodynamic equilibrium is not required, large magnetic fields in the plasma are permitted, and no information is required on the chemical composition of the plasma. (auth) (UK)

Kinetics (General)

17146 (JINR–P13-5504) DEBYE APPROXIMATION APPLIED TO THE AVALANCHE TO STREAM TRANSITION. Matyushin, A. T.; Matyushin, V. T. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The development of the avalanche and streamer in gases in a homogeneous electric field is studied, taking account the Debye screening radius. Based on the Langmuir plasma determination, a criterion for the avalanche-to-streamer transition is obtained, after some simplifications, which is proven by available experimental data. With the aid of this criterion an empirical constant αx_{kp} of streamer theory is explained, and the behavior of this constant when changing E/p is predicted. The criterion does not contradict the Loeb, Meek and Raether conditions. Some ratios applied to the streamer chambers are given. (auth)

17147 INVESTIGATION OF THE ACCELERATION OF IONS BY A PLASMA SHEATH. Clark, John Garner. Davis, Calif.; Univ. of California (1969). 116p. University Microfilms Order No. 70-25,132.

Thesis.

In order to calculate the ion energies at the boundary and the potential distribution in the plasma, a collisionless plasma consisting of electrons and protons contained between two infinite parallel conducting plates held at ground potential was used as a theoretical model. It was further assumed that those ions and electrons that reach the plates were totally absorbed and that no particles enter the system at the plates. The Vlasov equations in a dimensionless form were used to mathematically describe the system. A uniform Maxwellian plasma with no initial electric field present was initially confined between the plates and its time development was calculated on a CDC 3400 computer, using a modification of a two-step difference scheme developed by Lax and Wendroff. Mosaics were used to experimentally investigate the acceleration of the ions passing through a plasma sheath. The experimental plasma was produced by a hydrogen-loaded titanium washer stack. Good agreement was obtained between the theoretical predictions and the experimental results, confirming the existence of a plasma sheath acceleration next to the surface of the mosaic. (TSS) (Diss. Abstr. Int., B)

17148 CORRELATION BETWEEN MEASURED AND PREDICTED FLOW VELOCITIES AND TEMPERATURES OF TRANSIENT PLASMAS. Collier, Darrell Wayne. Fayetteville, Ark.; Univ. of Arkansas (1970). 183p. University Microfilms Order No. 70-26,212.

Thesis.

Plasmas accelerated in devices designed for that purpose inevitably do not achieve the flow velocities for which the devices are designed. Recognition of this fact has produced several theories. In one theory the plasma is held to interact through its positive ions with the walls of accelerating devices. The other theory indicates that the magnetic fields used to force the plasma from plasma-accelerating devices partially penetrate the plasmas rather than simply push them. In order to investigate these explanations, research was initiated with a simple plasma-accelerating device called a "rail gun" and plasmas produced by electrical breakdown in argon gas. Interpretation of the experimental results indicates that neither conjecture concerning the inability of plasmas to reach expected flow velocities is correct. The experimental results are shown to be internally consistent with a theory developed here which predicts the temperature and flow velocity of plasmas accelerated into neutral gas by a process called "snowplowing." The applicability of the snowplow theory indicates that the magnetic field that pushes the plasma does not appreciably penetrate the plasma. If the theory of interaction of moving plasmas with walls of accelerating devices were correct, marked disagreement between the snowplow theory and the experimental results would have been observed. Agreement between the snowplow theory and the experimental results indicates that snowplowing actually occurs, a fact which itself was in dispute. Inspection of the designs of previous devices in which plasmas have been accelerated indicates that the snowplowing effect very likely accounts for the inability of those devices to produce expected flow velocities. (Diss. Abstr. Int., B)

17149 PLASMA LIGHT SOURCES. Gabriel, A. H. (Culham Lab., Abingdon, Eng.). Nucl. Instrum. Methods; 90: 157-61 (1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

In confining this review to non-LTE plasmas, it is clear that the main emphasis, of relevance to beam–foil spectroscopy, is on separation of ion stages and line identification; only rarely can lifetimes be determined. The majority of line classifications for highly charged ions, carried out over the last forty years, have used the two-electrode vacuum spark, a source that is still in use today. Low-inductance-triggered vacuum sparks have produced spectra up to copper XXVIII and have some properties in common with the plasma focus source. Laser-generated plasmas with temperatures of 100 eV or higher offer unique facilities for separating neighboring stages of ionization. Magnetically confined plasmas are more homogeneous in temperature and often allow ion separation in time, during the ionizing phase. Astrophysical plasmas have a particular interest for forbidden-line studies. The forbidden coronal line identifications of nearly thirty years age are now being extended by new observations into the ultraviolet. Other new forbidden lines in the solar soft-x-ray spectrum have changed our understanding of helium-like ion lifetimes. (auth)

17150 OBSERVATION AND IDENTIFICATION OF HIGHLY STRIPPED IRON TRANSITIONS PRODUCED IN THE PLASMA FOCUS. Connerade, J. P. (ESRIN, Frascati, Italy); Peacock, N. J.; Speer, R. J. Nucl. Instrum. Methods; 90: 163-6(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

The multiply ionized iron spectrum between 10 and 17 Å produced in a Plasma Focus discharge is interpreted using Hartree–Fock computer calculations of the energy levels. A comparison is made between the Plasma Focus data and pre-flare spectra obtained in March 1967 from the OSO III satellite. (auth)

17151 INSTABILITIES OF BEAMS OF CHARGED PARTICLES IN A PLASMA. Nezlin, M. V. (Inst. of Atomic Physics, Moscow). Usp. Fiz. Nauk; 102: 105-39(Sep 1970). (In Russian).

A systematic review on electron–ion instabilities is given. Theoretical concepts of the instabilities are described and compared with experimental data. Nonlinear effects observed in experiments with intense (unstable) electron beams in plasma are analyzed. (82 references) (R.V.J.)

17152 DISSIPATION DISCONTINUITIES IN HYDROMAGNETIC SHOCK WAVES. Coroniti, F. V. (Univ. of California, Berkeley). J. Plasma Phys.; 4: 265-82(May 1970).

Within the hydromagnetic approximation, the effects of resistive, viscous, and thermal conduction dissipation on the structure of shock waves are studied. A perturbation analysis about the upstream and downstream stationary points is developed, which, when coupled with the shock evolutionary conditions, determines the conditions for the formation of discontinuities in the shock structure. The viscous subshock for fast shock waves and the hydromagnetic analogue of the gas-dynamic isothermal discontinuity for fast and slow shocks are analyzed. Very oblique fast shocks require both resistive and viscous dissipation for a steady shock structure. Strong slow shocks propagating nearly along the magnetic field fail to steepen if only resistive dissipation is included. The rotational discontinuity does not possess a stable shock structure for any of the dissipation processes considered. (auth) (UK)

17153 GENERATION OF ELECTRON–POSITRON PAIRS BY FOCUSING LASER RADIATION IN A DENSE PLASMA. Bunkin, F. V.; Kazakov, A. E. (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR; 193: 1274-5(21 Aug 1970). (In Russian).

Electrons with an energy higher than $3\,mc^2$ (m = mass of the electron; c = speed of light) may generate electron–positron pairs when scattered on nuclei. Such a situation may be examined experimentally even in a nonrelativistic plasma with a temperature $T \ll mc^2$ if the plasma is irradiated by a high-intensity electromagnetic wave such as a focused laser beam. One of the authors et al. examined this problem qualitatively in an earlier paper; that study is continued here, first by examining nonrelativistic electrons possessing a sufficient amount of energy to generate pairs without affecting the cross section of the process itself. It may be assumed that the energy ϵ of the scattered free electrons is equal to that of electrons in the field of the plane-monochromatic wave. The value of ϵ is given for the case of a plane-polarized wave, deriving also the highest electron concentration which still allows penetration of the radiation with a given wavelength λ into the plasma. The calculations indicated that the effect of electron–positron pairs in a laser experiment may be actually observed. Under the conditions considered, the absorption coefficient due to the multiphoton Compton effect is of the order of 10^{-3} cm^{-1}; thus, in the range examined the Compton effect determines the absorption of the radiation. (TTT)

17154 THEORETICAL AND EXPERIMENTAL STUDIES ON THE DIFFUSION OF LOW-FREQUENCY MAGNETIC FIELD INTO A MOVING PLASMA. Young, E. H. Jr.; Duesterhoeft, W. C. Jr. (Univ. of Texas, Austin). Plasma Phys.; 12: 799-813(Oct 1970).

The diffusion of the magnetic field into a plasma is quantitatively described by the MHD and Maxwell's equations. The MHD equations are simplified with reasonable approximations corresponding to experimental conditions from which the well-known vector magnetic equation is derived. The vector equation is separable for an axially symmetric system. Two solutions are obtained with one case for a finite plasma column bounded by a conducting wall. The other solution is for the case of a plasma in a semi-infinite medium. The experiment is performed with a coaxial plasma gun in a longitudinal magnetic guide field. Both spatial and time-resolved measurements of magnetic signals are made to obtain comparison with the theoretical solutions. (auth) (UK)

17155 EFFECT OF DIFFUSION ON CURRENT-SHEET SPEED IN A MAGNETICALLY DRIVEN SHOCK TUBE. Chang, C. T. (Danish Atomic Energy Commission, Risoe, Denmark); Popovic, M.; Korsbech, U. Plasma Phys.; 12: 751-7(Oct 1970).

The lowering of the current-sheet speed in a magnetically driven shock tube is attributed to the diffusion effect of the current and not to the anchoring of a large fraction of the total current near the driving end. (auth) (UK)

17156 CORRELATED BEAM DISTRIBUTION FUNCTIONS AT THE TRANSITION 1st–2nd REGIME IN A BEAM–PLASMA EXPERIMENT. Cabral, J. A.; Hopman, H. J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Plasma Phys.; 12: 759-77(Oct 1970).

In a beam–plasma experiment, with typical conditions $V_b = 1500$ V, $i_b \simeq 10$ mA, $p \simeq 5 \times 10^{-4}$ torr, the 1st–2nd regime transition is studied as a function of the axial magnetic field. The beam–plasma system is characterized by time-resolved measurements of the excited frequency spectrum, plasma density, and beam axial and transverse energy spreads. These parameters show strong fluctuations with a typical repetition frequency of about 30 kHz. Correlation measurements permit one to identify in the plasma, despite the dc character of the external parameters, two completely different states, observed respectively when the plasma, and cyclotron instabilities are present. These two instabilities alternate in time. Special attention is paid to the beam velocity distribution function which always shows a plateau, as a result of the excitation of beam–plasma instabilities. The largest velocity spread in the beam is attained during the cyclotron instability. In this case the velocity plateau is explained by the trapping of the beam electrons on the potential well of the cyclotron wave. Under these conditions, the axial electric field, at the beam centre, is found to be independent of the magnetic field. A radial analysis of the extension of the axial velocity spread in the beam is made for the case of the cyclotron instability. Theoretical Bessel function dependences on the radius are verified for the axial electric field. The beam axial power losses are calculated. These losses are found to decrease with the magnetic field. On the basis of the referred trapping mechanism, an explanation is given for this fact. (auth) (UK)

17157 NORMAL IONIZING SHOCK WAVES IN MIXTURES OF HYDROGEN, DEUTERIUM, AND HELIUM. James, B. W. (Sydney Univ.). Plasma Phys.; 12: 644-5(Aug 1970).

Results of the studies of the propagation of normal ionizing shock waves in mixtures of hydrogen and deuterium, hydrogen and helium, and deuterium and helium are reported. The experiment was undertaken in the Super II cylindrical shock tube. Theoretical and experimental values of shock velocity and azimuthal velocity for the gas mixtures and pure gases are tabulated and show good agreement for all pressure and gas combinations. (UK)

Kinetics (Experimental)

17158 (AD-712710) RATE PROCESSES IN NONEQUILIBRIUM PLASMAS. Final Technical Report. Evans, Norman A. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Jul 1970. Contract F44620-68-C-0048. 28p. (AFOSR-70-2480-TR). NTIS.

An experimental study of the establishment of nonequilibrium ionization in flowing cesium-seeded argon was continued, with emphasis on rate-controlled aspects. In addition to the usual ionization and recombination rates, a seed diffusion rate to the electrodes and an electrode thermal inertia were identified as possibly important in certain applications involving short running times. From the limited amount of data obtained, it was found that an applied transverse magnetic field increased the plasma power dissipation rate with respect to conductivity, the overall electron density recombination rate, and the required plasma breakdown voltage. (auth) (USGRDR)

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17159 FURTHER NOTE ON THE CONICAL Z PINCH. Pert, C. J. (Univ. of Alberta, Edmonton). Plasma Phys.; 12: 545-9 (Jul 1970).

In a previous paper (Pert, 1969) the operation of a conical z-pinch plasma gun was discussed. In contrast to other work (Guhart and Morita, 1965; Jahn et al., 1965; Fearn and Wooding, 1967) it was found that only about 60% of the plasma ejected from the discharge was accelerated by the electromagnetic forces in the current sheet. The remainder was due to expansion of the pinched gas column as found with a θ-pinch device by Cruddace and Hill (1966). The pinching action of the discharge is restrained by the presence of an axial magnetic field. The development of instabilities in the "pinch" thus formed is also restrained and allows a longer time for the ejection of plasma from the central column. However, as the axial acceleration of plasma by the current sheet takes place only near the discharge axis, electromagnetic acceleration produces a negligible proportion of the ejected plasma in this case due to the restraint of the pinch. (auth) (UK)

17160 MICROWAVE RADIATION FROM THE HELIUM NEGATIVE GLOW. Caron, Paul R. (Southeastern Massachusetts Univ., North Dartmouth); Haroules, G.; Brown III, W. J. Appl. Phys.; 42: 873-6(Feb 1971).

Some experimental results are presented on microwave noise emission near the plasma frequency from the helium negative glow. In particular, it is shown that the noise emission is greatly enhanced near the cathode and this enhancement is attributed to the presence of high-energy electrons near this electrode. (M.O.W.)

17161 RESONANCES AT THE HARMONICS OF THE ELECTRON CYCLOTRON FREQUENCY IN LABORATORY PLASMAS. Landauer, G. (European Space Research Inst., Frascati, Italy). pp 235-42 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

Measurements were made of cyclotron harmonic emission in PIG discharges in the pressure range 6×10^{3} to 5×10^{-2} torr. Measurements are also given of cyclotron harmonic emission with self-absorption lines. (M.O.W.)

17162 X RADIATION FROM OPTICAL AND INNER-SHELL TRANSITIONS IN A HIGHLY IONIZED DENSE PLASMA. Lie, T. N. (Catholic Univ. of America, Washington, D. C.); Elton, R. C. Phys. Rev., A; 3: 865-71(Mar 1971).

X-ray line emission originating from "optical" (dipole and intercombination) transitions in helium-like copper, iron, and titanium and hydrogenic iron and titanium ions was observed in a concentrated dense plasma formed in a linear low-pressure discharge. In addition, emission from inner-shell x-ray transitions in Fe XIX–XXIV and Ti XV–XX ions was identified. The measured wavelengths are compared with theoretical predictions and other observations. Continuum emission at wavelengths shorter than the Lyman-series limit for hydrogenic species was used for electron temperature and density determination and as evidence supporting a thermal-electron collisional ionization model. Plasma dynamics studies indicate the existence of an axially propagating radial pinch, collapsing near the anode to a minute point. (auth)

17163 COLLISIONAL IONIZATION RATES FOR LITHIUM- AND BERYLLIUM-LIKE IONS. Kunze, H.-J. (Univ. of Maryland, College Park). Phys. Rev., A; 3: 937-42(Mar 1971).

Collisional ionization rates for C IV, N V, and O VI as well as for O V and Ne VII are deduced from the time history of spectral lines emitted by these ions in a hot plasma. The plasma (in the electron temperature range 100 to 260 eV) is produced in a 15-kJ theta-pinch device, and it is analyzed using the light-scattering technique. The results are consistent with theoretical calculations for O VI and with a semiempirical formula based on theoretical calculations for hydrogenic ions but smaller by factors 1.5 to 2. (auth)

Kinetics (Theoretical)

Refer also to abstracts 17129 and 17230.

17164 (AD-713124) PARTICLE FLUX ASSOCIATED WITH STOCHASTIC PROCESSES. Newman, C. E.; Sturrock, P. A.; Tademaru, E. (Stanford Univ., Calif. Inst. for Plasma Research). 17 Sep 1970. Contract F44620-69-C-0008. 11p. (SU-IPR-386). NTIS.

The Lagrange expansion, which may be used to derive the Fokker–Planck equation, is used here to derive the corresponding expression for the flux of particles subject to a stochastic scattering process. The coefficients that occur in this expression are, in general, not the same as the coefficients which occur in the Fokker–Planck equation itself. In the special case that the particle distribution involves only one independent variable, the particle flux is determined by the familiar Fokker–Planck coefficients. Evaluation of particle flux is of special interest in the study of stochastic acceleration. (auth) (USGRDR)

17165 (AD-713485) PENETRATION OF PHOTONS THROUGH A HOT ELECTRON GAS. Final Report. Hui, S.; Kalos, M. H.; Steinberg, H.; Troubetzkoy, E. (Mathematical Applications Group, Inc., White Plains, N. Y.). Jun 1970. Contract DASA01-69-C-0150. 64p. (MR-7006; DASA-2556). NTIS.

The work reported here is the first phase of the study of improved techniques for determining the time-dependent history of a radiation field. A standard problem of the penetration of a Planck spectrum of photons through a hot electron gas is solved by the Monte Carlo technique. A code to calculate the energy and angular spectrum of transmitted radiation was written in which no attempt was made to include stimulated scattering or any other nonlinear effects. Such nonlinear effects will be included in the second phase of this study and the calculations here will be repeated. Results for several spectra at different temperatures and a medium of an electron gas of temperature between 0 and 20 keV are given. (auth) (USGRDR)

17166 (AD-713576) PROPAGATION OF HIGH-INTENSITY RELATIVISTIC ELECTRON BEAMS. Roberts, Thomas G. (Army Missile Command, Redstone Arsenal, Ala.). 1970. 13p. NTIS.

Intense beams of relativistic electrons were extracted from the electrode space of flash x-ray machines and projected into plasma columns and drift spaces. In the plasma columns the beam pinches itself and propagates to a target at the end of the discharge. The plasma column is produced by a conventional pinch discharge in argon, and the magnetic field of the plasma column is sufficient to guide the high-energy beam around rather sharp curves with little loss of energy. In addition to the very interesting properties of the beam itself and its applications in thermonuclear work, the possibility of using these beams for a relatively inexpensive ion accelerator to produce intense pulses of heavy ions with energies as high as 10^{12} eV per nucleon has recently stimulated research. The principal experimental results so far obtained are described here, and an expression is derived for the maximum current that a beam may possess by use of the Bennett theory and the equilibrium current distribution that the beam must assume. It is also shown that this expression reduces to the Alfven limit in a frame in which the beam's space charge is fully neutralized, and indications are that beams exceeding the Alfven limit may be expected to propagate in the laboratory frame. (auth) (USGRDR)

17167 (CU-3954-6) MODIFIED PARTICLE-IN-CELL METHOD FOR COLLISIONAL PLASMAS. Chu, C. K.; Gula, W. P. (Columbia Univ., New York); Mason, R. J. (Bell Telephone Labs., Inc., Whippany, N. J.). [1970]. Contract AT(30-1)-3954. 17p. (CONF-701113-4). Dep. NTIS.

From 4th Conference on Numerical Simulation of Plasmas, Washington, D. C.

A modification of the standard simulation codes is proposed in which each simulation particle is interpreted as an element of phase space, with the value of the distribution function attached. For a collisionless plasma, this value is constant for each particle; when collisions are present, this value is modified according to the collision operator. One-dimensional problems are considered, and the Krook model operator is used for the collisions. Results are obtained for shock-wave formation in a rarefied neutral gas and for collisional damping of the two-stream instability in a plasma. (auth)

17168 (UCRL-50002-70, pp 1,1-36) THEORETICAL STUDIES. (California Univ., Livermore. Lawrence Radiation Lab.).

From Controlled thermonuclear research.

Brief discussions are given for the various research undertaken on the following areas: (1) computer simulation, (2) mirror research, (3) Astron research, (4) toroidal research, and (5) nonlinear theory, atomic physics, and other studies. (M.O.W.)

17169 VELOCITY-SPACE DIFFUSION AND LANDAU DAMPING OF PLASMAS WITH COLLISIONS IN QUASI-LINEAR REGIME. Li, Kwok-Leung. New York; City Univ. (1970). 73p. University Microfilms Order No. 70-24,478.

Thesis.

The statistical behavior of a fully ionized plasma is investigated by means of a kinetic equation, including collision terms, of the form of the Krook and the Fokker–Planck models. These equa-

tions, coupled with the Poisson equation, are solved by the method of characteristics using the quasi-linear approximation technique. Dispersion relations for longitudinal oscillations of the plasma are obtained; Landau damping coefficients of the waves as well as diffusion coefficients in velocity space are explicitly evaluated. These coefficients reveal effects due to the inclusion of both nonlinear and collisional terms in the kinetic equations. Temporal development of electrostatic energy fluctuations and that of the particle distribution are then examined. Application is made to a plasma with a background distribution possessing a bump. Wave growth is shown to increase wave diffusion, and consequently, the bump disappears gradually; as a result, the electrostatic energy decreases to zero, so that the distribution tends to an equilibrium limit, as described by the original kinetic equation. This result is not predicted by the quasi-linear theory of a Vlasov plasma in which a physically unrealistic plateau is formed. (Diss. Abstr. Int., B)

17170 PARAMETRIC INTERACTIONS IN BEAM–MAGNETOPLASMA SYSTEMS. Stone, Francis Thomas. Brooklyn; Polytechnic Inst. (1970). 154p. University Microfilms Order No. 70-26,107.

Thesis.

The linearized multibeam approach to finding self-consistent wave solutions in plasmas has been used successfully for many systems, in particular for finding instabilities in plasmas with only longitudinal temperature. This technique is extended here to general plasma systems. The general equations are formulated and solved for the special cases: longitudinal propagation in a plasma isotropic in the transverse plane of velocity space; and arbitrary propagation in a plasma with only longitudinal temperature. A homogeneous sinusoidal electric field transverse to the applied magnetostatic field is also introduced into the equations. It is shown that the effect of this field on a plasma with only longitudinal temperature is to produce a beam of charged particles anisotropic in the transverse plane of velocity space. The equations are specialized to the case of longitudinal propagation. It is shown that single-frequency wave perturbations are only possible when fourfold symmetry in the transverse plane of velocity space is present. The equations are specialized to the case of electrostatic interactions. The general equations are solved for plasmas isotropic in the transverse plane of velocity space, yielding the Harris modes. For the anisotropic case the interactions between only two isotropic modes are considered, with the long-wavelength approximation used to simplify the analysis. The growth rate for the upper hybrid–lower hybrid interaction is calculated, and an attempt is made to explain striations in bounded structures using this instability. (TSS) (Diss. Abstr. Int., B)

17171 THEORY OF THE POSITIVE COLUMN OF A GAS DISCHARGE. Lindgren, Robert Gary. Pasadena, Calif.; California Inst. of Tech. (1970). 447p. University Microfilms Order No. 70-24,305.

Thesis.

An attempt is made to provide a theoretical explanation of the effect of the positive column on the voltage–current characteristic of a glow or an arc discharge. Such theories have been developed before, and all are based on balancing the production and loss of charged particles and accounting for the energy supplied to the plasma by the applied electric field. Differences among the theories arise from the approximations and omissions made in selecting processes that affect the particle and energy balances. This work is primarily concerned with the deviation from the ambipolar description of the positive column caused by space charge, electron–ion volume recombination, and temperature inhomogeneities. (TSS) (Diss. Abstr. Int., B)

17172 CONTINUUM THEORY OF THOMSON SCATTERING. Seasholtz, Richard George. Cleveland; Case Western Reserve Univ. (1970). 91p. University Microfilms Order No. 70-25,915.

Thesis.

The theory of Thomson scattering from a weakly ionized plasma is extended to include the effects of unequal electron and ion temperatures, a uniform dc magnetic field, and electron drift. The Born scattering formula and the fluctuation–dissipation theorem are used to calculate the differential backscatter cross section. The plasma is described by the hydrodynamic (continuum) equations for the conservation of mass, momentum, and energy of each species which are valid if the wavelength of the probing wave is greater than the ion–neutral mean free path. With no magnetic field, the backscattered power is shown to be generally less than that found from a collisionless calculation and is dependent on the ion–neutral and electron–neutral collision frequencies when the electron to ion temperature ratio $T_e/T_i \neq 1$. A magnetic field normal to the incident wave causes the back-scattered power to be increased for T_e/T_i in the common experimental range of 1 to 10; it is shown that the scattered power may increase with T_e/T_i rather than falling off in accord with the usual $(1 + T_e/T_i)^{-1}$ relation. The effect of electron drift (less than the critical velocity corresponding to the onset of instability) on the Thomson scatter spectrum and on the total scattered power is calculated. As the electron drift velocity is increased, the spectrum develops a sharp peak at a frequency shift corresponding to the ion-acoustic wave and the total scattered power is enhanced. The new results presented make it possible to analyze Thomson scatter experiments in the lower ionosphere and in very dense laboratory plasmas where collisional effects are important and where prior kinetic theory treatments are not readily applicable. (Diss. Abstr. Int., B)

17173 POLARIZATION SHIFTS IN PLASMA. Tsuji, Akio; Narumi, Hajime (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 44: 1424-5(Nov 1970).

Plasma polarization shifts are so sensitive to the radial distribution at small distance that quantum approach should inevitably be required. Along this line the polarization shift in plasma is formulated by using a self-consistent field method, and the calculated result is compared with the recent experimental data for a resonance line of ionized helium (Grieg, et al., Phys. Rev. Letters, 24: 3(1970)). (auth)

17174 EFFECTS OF FINITE LARMOR RADIUS ON THE PERTURBATION FLOW MIXING OF A COLLISIONLESS PLASMA. Morioka, Shigeki (Ames Research Center, Moffett Field, Calif.); Spreiter, John R. J. Plasma Phys.; 4: 403-24(May 1970).

The Chew–Goldberger–Low theory of a collisionless plasma, modified to include the effect of finite Larmor radius of the ion and the electron, was applied to a linearized problem of two-dimensional steady flow. The zeroth-order terms in the Larmor-radius expansions of the velocity distribution functions of the ion and the electron were assumed to be anisotropic Maxwellian. The spatial development of a given velocity profile was investigated for flows with either crossed or aligned magnetic fields, and for various values of Mach number, Alfvén Mach number, and anisotropic pressure ratios in the main flow. (auth) (UK)

17175 EFFECTIVE FIELD FORMULATION OF PLASMA KINETIC THEORY. Baus, M. (Univ., Brussels). Ann. Phys. (N. Y.); 62: 135-71(Jan 1971).

The kinetic theory of classical Coulomb plasmas is formulated in terms of an effective electric field representing the response of the plasma medium to a set of fluctuating particles. The diffusion and friction coefficients of the particle kinetic equation are written explicitly in terms of this effective field. For wave vectors of the order of the Debye wave vector, the effective field can be computed from a linearized Vlasov equation and yields the first order in the plasma-parameter kinetic equations. For small wave vectors of the order of the inverse of the 90° deflection mean free path, the effective field can be computed from an inhomogeneous Balescu–Guernsey–Lenard (BGL) equation containing a nonlinear Vlasov term and a BGL-like collision term. Retaining only the lowest-order nonlinear corrections, the kinetic equations recently derived by Rogister and Obermann are recovered while some collisional-damping contributions missing in the latter kinetic equations are included. Finally, the contribution from collision-dominated waves is discussed as well as the close-encounter contributions to the effective electric field. (auth)

17176 QUANTUM KINETIC THEORY OF A HOMOGENEOUS SYSTEM OF CHARGED PARTICLES. Lie, Tae-Journ. Ithaca, N. Y.; Cornell Univ. (1970). 194p. University Microfilms Order No. 70-12,633.

Thesis.

The two-particle correlation function C_2 of a homogeneous quantum system of charged particles is formulated in order to establish a kinetic equation and also to derive, as a by-product, a formula for the equilibrium correlation energy $E_{Corr.}$. Quantum effects of particle exchange are systematically included in this formalism. The BBKGY hierarchy is derived from the Hamiltonian presented in terms of second quantization operators. Through a high-density approximation, the equation for the two-particle correlation C_2 is brought into a mathematically tractable form. Its solution is given in terms of two dielectric functions D_1 and D_2. The former, D_1, shields external potentials, while the latter, D_2, shields inter-particle potentials between constituent particles of the system. The kinetic equation in the random-phase approximation is reviewed a bit more in detail. Its long-time behavior part is given by the Balescu–Lenard equation. The transitional part, which decays in time exponentially, is called the quasi-linear term. Presence of this term insures total energy conservation and, also, permits physical interpretation of relaxation phenomena, for the case of an electron plasma, in terms of electron–plasmon interactions. The formula for the correlation energy involves $\mathrm{Im}(1/\epsilon(k,\omega))$ in a form in agreement with existing theories. The Gell-Mann–Brueckner calculation of the electron gas correlation

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energy at zero temperature approximates $\epsilon(k,\omega)$ by the exchangeless dielectric constant $\epsilon_0(k,\omega)$, which is a small k approximation. The Hubbard formula for this problem amounts to approximating the exchange factor $d_1(k,\omega;p)$ involved in the expression of $\epsilon(k,\omega)$ by an appropriate function $d_H(k,\omega)$ in such a way that both the large and small k limits are reasonably satisfied. Here again, the present formalism demonstrates its function of bridging the large and small k approximations. (TSS) (Diss. Abstr. Int. B)

17177 EFFECT OF RADIATION ON A CYLINDRICAL MAGNETOGASDYNAMIC SHOCK IN A PLASMA. Verma, B. G. (Univ. of Gorakhpur, India). Pure Appl. Geophys.; 81: 124-9 (1970/IV).

The propagation of radiative, cylindrical, and magnetohydrodynamic shocks is studied. The jump conditions in terms of Mach number and the ratios of radiation pressure and material pressure as well as material pressure and magnetic pressure are described. (auth)

17178 ASYMPTOTIC MATCHING OF PLASMA AND SHEATH IN AN ACTIVE LOW-PRESSURE DISCHARGE. Franklin, R. N.; Ockendon, J. R. (Oxford Univ.). J. Plasma Phys.; 4: 371-85 (May 1970).

The method of matched asymptotic expansions is applied to the fluid model of the low-pressure positive column. The expansion of the eigenvalue in the plasma balance equation is obtained to second order in plane and in cylindrical geometry, and uniformly valid expressions for charged-particle densities and fluid velocity in two separate regions are indicated. The free-fall model is also examined, and the scales of the transition layer and sheath layer are found. Comparison is made with the results of direct numerical integration of the equations involved for both models. (auth) (UK)

17179 SUPPRESSION OF RUNAWAY ELECTRONS IN A LORENTZ PLASMA. I. HARMONICALLY TIME VARYING ELECTRIC FIELD. Abraham-Shrauner, Barbara (Washington Univ., St. Louis). J. Plasma Phys.; 4: 387-402(May 1970).

The suppression of runaway electrons in a Lorentz plasma was demonstrated for a two-component, fully ionized plasma in the presence of a high-frequency, weak, uniform electric field. The time of runaway to occur for electric field frequencies high compared to the collision frequency was longer than the runaway time for low electric field frequencies or zero frequency, by the ratio of the frequency of the electric field to the collision frequency squared. Both the resolvant method developed by Prigogine and co-workers and the double perturbation scheme of the Poincaré–Lighthill method were employed to derive the diffusion equation for the modified one-particle distribution function in the collision-dominated region of velocity space. (auth) (UK)

17180 PROBLEMS OF DETERMINATION OF HIGH-TEMPERATURE THERMODYNAMIC PROPERTIES OF RARE GASES WITH APPLICATION TO MIXTURES. Capitelli, M.; Molinari, E. (Univ., Bari, Italy). J. Plasma Phys.; 4: 335-55(May 1970).

Thermodynamic properties and compositions of gases in thermal equilibrium at high temperature can, in principle, be derived quite accurately once the partition functions of the relevant species have been calculated. There are, however, a number of problems that have to be solved for an accurate evaluation of equilibrium properties. In particular, the criteria adopted for the cutoff of the partition functions and the estimation of missing energy levels are of paramount importance in the evaluation of the partition functions of the single species. In the present work, which deals with calculations of equilibrium properties of mixtures of nitrogen with the rare gases helium, argon, and xenon at one atmosphere between 5000 and 35,000°K, these problems are examined in some detail. (auth) (UK)

17181 ANISOTROPIC PLASMA PRESSURE AND THE DIELECTRIC TENSOR. Johnston, Tudor Wyatt (RCA Research Labs., Montreal). J. Plasma Phys.; 4: 283-95(May 1970).

The first-order temperature terms for the anisotropic-temperature plasma susceptibility are calculated for each species, using the velocity moment equations and circular polarized coordinates. The results agree with the expanded terms for the Vlasov equation solution, for which a usefully simple derivation is given. An electrostatic wave result is given. Drift can be included by a transformation of the results for zero drift. (auth) (UK)

17182 WEAK TURBULENCE OF VELOCITY SPACE DIFFUSION IN A MAGNETIC FIELD. Manheimer, W. M. (Massachusetts Inst. of Tech., Cambridge). pp 523-34 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

The wave–particle interaction in a weakly turbulent plasma was investigated in the presence of a uniform magnetic field. Stochastic particle acceleration is discussed, and the relationship between particle acceleration and nonlinear cyclotron damping is described. (M.O.W.)

17183 INTERACTION OF ELECTRON BEAM WITH NONUNIFORM PLASMA. Kogan, E. Ya.; Lisitchenko, V. V. (Kiev State Univ.). Ukr. Fiz. Zh.; 15: 1446-52(Sep 1970). (In Russian).

Peculiarities are considered of wave generation by electron beams in nonuniform plasma in the beam direction. The dispersion-relation oscillations are obtained in the kinetic approximation. Influence of plasma nonuniformity on the Landau d .ping is studied. (auth)

17184 STUDY OF BEAM–PLASMA INTERACTION IN BOUNDED SYSTEMS. Pakhomov, V. I.; Zayed, K. E. (Atomic Energy Establishment, Cairo). Physica; 50: 467-76(7 Dec 1970).

The interactions of a charged-particle beam with electrostatic surface waves in a plasma layer and in a vacuum layer in a plasma are investigated. The case of an isotropic plasma and that with an external magnetic field are considered. The expressions for the growth rates of the waves excited by cold beams and beams with a great thermal spread of particle velocities are obtained. (auth)

17185 GROWTH RATES AND STABILITY LIMITS FOR BEAM–PLASMA INTERACTION. Self, S. A.; Shoucri, M. M.; Crawford, F. W. (Stanford Univ., Calif.). J. Appl. Phys.; 42: 704-13(Feb 1971).

A treatment is given of the one-dimensional problem of beam–plasma interaction, including the effects of plasma and beam thermal velocities and momentum transfer collisions in the plasma. The conditions under which the Landau damping due to the plasma is negligible are first investigated. Neglecting this damping, a weak-beam approximation to the dispersion relation is derived, and conditions for its validity are established. Expressions are derived for the maximum temporal and spatial growth rates in the limits of cold and hot beams, and few and many collisions. The growth rates given by the weak-beam approximation are compared with those calculated from the full dispersion relation. The transition from a cold to a hot beam is discussed in terms of the topology of the roots of the dispersion relation, and also in terms of the location of the phase velocities of the most unstable waves relative to the bump in the distribution. (auth)

17186 PARTICLE ORBITS IN A CONSTANT MAGNETIC FIELD AND TRANSVERSE ELECTROMAGNETIC WAVE. Woolley, M. L. (Univ. of Sussex, Brighton, Eng.). Plasma Phys.; 12: 779-87(Oct 1970).

A method is given whereby the relativistic equations of motion of a charged-particle moving in the field configuration of a circularly polarised plane electromagnetic wave propagating along a uniform magnetic induction can be integrated analytically to give explicit functions which describe the orbital motion. For the particularly simple case of a medium of-refractive index unity, it is shown that the trajectories can be classified into (1) bounded trajectories in which the particle has bounded energy (2) unbounded trajectories in which the particle has bounded energy and (3) unbounded trajectories in which the particle has unbounded energy. (auth) (UK)

17187 QUASI-AMBIPOLAR DIFFUSION IN ARC DISCHARGES IN A MAGNETIC FIELD. Hassan, H. A.; Thompson, C. C. (North Carolina State Univ., Raleigh). Plasma Phys.; 12: 727-36(Oct 1970).

An analysis of arc discharges in which changes normal to the electrodes are more important than those along electrodes is presented. In this case, the current is different from zero and the diffusion is not ambipolar. Both planar and axisymmetric discharges in the presence of a magnetic field are considered. This analysis is based on the complete conservation of mass and momentum equations for the ions and electrons. Using the complete equations leads, in the plasma approximation, to plasma boundaries which correspond to the anode and cathode sheaths. The positions of the boundaries and the values of the ions and electron velocities there depend, among other things, on the current density, magnetic field strength, pressure and temperatures. The results indicate that the number density has a maximum somewhere between the anode and cathode sheaths. Also, depending on the geometry, current density, and magnetic field strength, potential inversion takes place near the sheaths. (auth) (UK)

17188 EFFECT OF IMPURITIES ON THE SPECTRUM OF LASER LIGHT SCATTERED BY A PLASMA. Evans, D. E. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Plasma Phys.; 12: 573-84(Aug 1970).

The expression for the frequency distribution of electron-density fluctuations in a plasma containing more than one ionic species is used as the basis for numerical computation to investigate the effect of varying the charge, mass and abundance of impurity ions on the ion feature of the scattered light spectrum. The calculation is done for various values of the electron/ion temperature ratio and for correlation parameter $\alpha = 1$ and $= \infty$. The effect of a temperature difference between the two ionic species in the plasma is also studied. (auth) (UK)

17189 EXCITATION OF SURFACE WAVES BY A BEAM OF GYRATING PARTICLES IN MAGNETOACTIVE PLASMA. El-Siragy, N. M.; Pakhomov, V. I. (Atomic Energy Establishment, Cairo). Plasma Phys.; 12: 685-90(Sep 1970).

The interaction of electrostatic surface waves at the plane boundary between a magnetoactive plasma and vacuum with an inhomogeneous beam of electrical oscillators moving outside the plasma parallel to its boundary is studied. Expressions for the wave growth rates due to this interaction are obtained. (auth) (UK)

Production

17190 INVESTIGATION ON A PRECURSOR IONIZATION IN AN ELECTROMAGNETICALLY DRIVEN SHOCK TUBE. Geile, H. J. (Technische Hochschule, Aachen). Atomkernenergie; 16: 187-90(1970). (In German).

The phenomena observed during the discharge of an electromagnetically driven shock tube in form of a conical theta pinch are studied. This observed phenomena is a pre-ionization. It could be shown that this ionization is built up by short vacuum-uv flashes that occur during the compression phases of the pinch discharge. Because of the short periods of the swinging discharge, the electron density of the precursor ionization grows up in several steps. The electron density shows a strong dependence from the pressure in all investigated gases. A relation was found for the neutral gas density and several parameters of the observed gases that describe the measured electron density. By this relation the energy that the shock wave and the following plasma lose by ionizing radiation could be estimated. (auth)

17191 TURBULENTLY HEATED ELECTRON PLASMA. Stirling, W. L.; Alexeff, I. (Oak Ridge National Lab., Tenn.). Plasma Phys.; 12: 489-502(Jul 1970).

The objective of this work was to produce a dense, ionizing plasma that could be used to shield a central hot-ion plasma core against the influx of neutral gas or impurities. For a plasma to be an effective shield against Franck–Condon neutrals (spontaneously generated, energetic hydrogen atoms), the plasma density times the plasma thickness should be equal to or greater than 10^{14} particles/cm^2. A unique, high-energy, high-density electron plasma annulus, which exists in a magnetic mirror of 2:1 ratio and operates in hydrogen gas at pressure of 3×10^{-5} torr, was developed. The hot electrons are produced in a high-voltage reflex discharge, or "arc." The arc electrodes are placed off the magnetic axis in the throats of their respective mirror coils. When heating takes place, the hot electrons are trapped in the magnetic mirror field and drift azimuthally due to the $\nabla B \times B$ precession. In this way a hot electron plasma annulus is created about the magnetic axis of the machine. Three different electron energy distributions were observed simultaneously: one of 10^9 to 10^{10} cm^{-3} density at about 100-keV electron temperature; a second of 10^{11} to 10^{12} cm^{-3} density at about 2-keV electron temperature; and the third a cold plasma of a few eV for the electron temperature at a density greater than 10^{12} cm^{-3}. An increase in magnetic field by a factor of 3 reduces the electron density in the annulus by a factor of about 5; however, the hot electron density generated at the main arc column is not appreciably affected. The plasma density in the annulus is about a factor of 50 too low to be an effective shield against Franck–Condon neutrals. (auth) (UK)

17192 PRODUCTION AND APPLICATION OF Li AND Sr PLASMA IN A Q DEVICE. Hashmi, M.; Van Der Houven Van Oordt, A. J.; Wegrowe, J.-G. (Institut fuer Plasmaphysik GmbH, Munich). Plasma Phys.; 12: 642-4(Aug 1970).

Lithium and Sr plasmas were produced in the Q-device Barbara to extend the range of plasma parameters to further the understanding of contact-ionization plasmas. With the production of these Li and Sr plasmas, contact-ionization plasma sources are available with ionization potential ranging from 3.89 to 5.67 eV (which allows a change of the Langmuir function by a factor 10^3) and atomic weight from 6.9 (Li) to 137.4 (Ba). The latter range affords the possibility for investigations where variation of the ion mass is an important feature, and also Sr plasmas can be used for estimating the oscillator strengths of the resonance transitions of Sr^+. (auth)

Stability

Refer also to abstracts 16691, 16734, 17151, and 17168.

17193 (EUR-CEA-FC-551) MAGNETOHYDRODYNAMICS STUDY OF EQUILIBRIA OF PLASMAS WITH EVOLUTION SYMMETRY. Misguich, J. H. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jul 1970. 178p. Dep. NTIS (U. S. Sales Only).

The MHD equations are studied in the cylindrical approximation for toroidal plasmas with revolution symmetry (Tokamak). The dependence of the poloidal β on the diffusion and on the anisotropy of the electrical conductivity is examined; a simple model of the energy balance allows a rather good evaluation of the energy confinement time for T3 and TM3. The MHD equations with revolution symmetry, and including toroidal effects, are derived. The class of linear equilibria, solved by Adam and Mercier, is used to obtain the local diffusion velocity distribution in the plasma. The Shafranov result for the equilibrium position of the plasma is generalized for an external medium with a nonvanishing current density. A new class of equilibria, exponential, is then solved and applied to a simple energy balance model and to the description of the external medium surrounding the plasma in the screw-pinch: an expression is derived for the displacement of the plasma, which yields a slightly larger value than the corresponding result of Bobeldijk. The functional form of equilibria with vanishing velocity and constant resistivity, at least for the force-free case, is in agreement with Jette and Screenivasan; the only nondegenerate equilibria belong to the linear class. (auth) (France)

17194 STABILITY OF FINITE-PRESSURE PLASMA WITH TRAPPED PARTICLES. Mikhailovskii, A. B.; Fridman, A. M. Dokl. Akad. Nauk SSSR; 194: 551-2(21 Sep 1970). (In Russian).

Previously B. B. Kadomtsev (Zh. Eksp. Teor. Fiz., 4: 15(1966)) showed that confined particles may induce plasma instabilities similar to the grooved instabilities. This was related to the zero pressure plasma $\beta = 8\pi\rho/\beta^2 \to 0$. A qualitative analysis, similar to that of B. B. Kadomtsev, was made for a plasma of finite pressure. The perturbations were assumed to be potential. Results showed that the instability of confined particles does not develop at $\beta > a/R$ because of the stabilizing influence of diamagnetic drift related to the finitude of β. In the case of groove instability the influence of diamagnetic drift and nonpotential perturbations compensate each other, thus the dispersion equation for grooved perturbations remained identical at large and small β. Plasma remained stable as soon as the diamagnetic drift exceeded the curvature-produced drift. (R.V.J.)

17195 EFFECT OF COLLISIONS ON THE TAYLOR AND KELVIN INSTABILITIES IN A COMPOSITE MEDIUM. Bhatia, P. K. (Monash Univ., Clayton, Australia). Cosmic Electrodyn.; 1: 269-72(Dec 1970).

The effects of collisions with neutral atoms on the stability of Rayleigh–Taylor and Kelvin–Helmholtz configurations are investigated. The longitudinal mode of wave propagation for the case of two superposed uniform fluids is considered. It is found that the collisions have a stabilizing influence on both the configurations. (auth)

17196 STABILITY OF A ROTATING STREAMING PLASMA. Bhatia, P. K. (Monash Univ., Clayton, Australia). Cosmic Electrodyn.; 1: 273-8(Dec 1970).

Stability of the well-known Kelvin–Helmholtz configuration is investigated to include the effects of finiteness of the ion Larmor radius in the presence of coriolis forces. The study was carried out for a streaming plasma in which there is a one-dimensional density gradient in a direction transverse to that of the direction of the uniform magnetic field. It is found that the unstable configuration is stabilized over a certain wave-number range of perturbations. Also, it is found that the greater the angular velocity of the plasma the greater the wave-number range of perturbations that are stabilized. (auth)

17197 EXPERIMENTAL OBSERVATION OF THE DRIFT DISSIPATIVE INSTABILITY IN AN AFTERGLOW PLASMA. Alcock, M. W.; Keen, B. E. (Culham Lab., Abingdon, Eng.). Phys. Rev., A; 3: 1087-96(Mar 1971).

Measurements are reported on low-frequency self-excited oscillations in an inhomogeneous afterglow plasma, in which

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there is a radial-density gradient perpendicular to an axial homogeneous magnetic field. The plasma was produced either by using a short pulse of electrons emitted from a hot cathode to ionize the background gas, or by pulsing off an rf discharge. The plasma so formed had an initial density of $\sim 10^{10}$ ion cm^{-3} and a temperature $T_e \sim 1000°K$. The experiment was carried out using tubes of 2.5 and 5.0 cm diam, giving inverse density scale lengths for the radial density gradient of ~2.3 and ~1.3 cm^{-1}, respectively. The oscillations occurred mainly as m = +1 azimuthal modes, although some results from m = +2 were obtained. The oscillations were shown to be standing waves in the axial direction z with a wavelength λ_z, approximately equal to the column length. It was found that the frequency of oscillation ω was dependent on the column length and by varying this, a dispersion relationship ω vs $k_z = (2\pi/\lambda_z)$ could be plotted under various conditions. It was found that the frequency was independent of time (or density) in the afterglow and that the frequency of oscillation tended to zero as $k_z \to 0$ and to ω^* as k_z assumed larger values. The simple theory of drift-dissipative instabilities was extended to include effects due to electron–neutral and ion–neutral collisions and the Re(ω), and growth rates Im(ω), vs k_z were calculated for the relevant experimental cases. Comparison of theory and experiment shows remarkably good agreement, considering the possible errors in some of the experimental quantities and the assumptions present in the theory. (auth)

17198 EFFECT OF NONUNIFORM ELECTRIC FIELDS ON DRIFT INSTABILITIES. Dobrowolny, M. (CNEN, Frascati, Italy). Plasma Phys.; 12: 463-76(Jul 1970).

A general equation describing drift instabilities in a low-β plasma, in the presence of nonuniform electric fields perpendicular to the magnetic field, is derived using a guiding-center fluid picture for the ions and the drift kinetic equation with a Krook-like collision term for the electrons. Both the collisionless and the collisional regime and, therefore, also the transition between them, can thus be described starting from the same equation. The equation is discussed and the influence of the electric field studied in the framework of a local approximation. (auth) (UK)

17199 CYCLOTRON RESONANCE INSTABILITY IN ROTATING PLASMA. Rozhkov, A. M.; Stepanov, K. N.; Suprunenko, V. A.; Farenik, V. I.; Vlasov, V. V. (Physical-Tech. Inst., Kharkov). Plasma Phys.; 12: 519-27(Jul 1970).

The excitation of ion cyclotron oscillations is studied experimentally in plasma in crossed electric and magnetic fields. When the frequency of rotation of the plasma column due to drift in the crossed fields is a half-multiple value of the ion gyrofrequency, then simultaneously with the development of a cyclotron resonance instability, a continuous excitation was observed in the discharge of large-amplitude ion cyclotron oscillations energized by the external dc supply. The growth rate of the instability is of the order of the ion gyrofrequency. (auth) (UK)

17200 LOW-FREQUENCY INTERCHANGES. Spies, Guenther Otto (Institut fuer Plasmaphysik, Garching, Ger.). Plasma Phys.; 12: 647-60(Sep 1970).

A necessary stability criterion is derived for a class of self-consistent low-β longtime guiding-centre equilibria. This class is defined by some restrictions, viz. symmetry, zero electric field, small ratio of guiding-centre drift velocities and diamagnetic velocities, and stability on the time scale of the longitudinal guiding-centre motion. Open-ended as well as toroidal configurations (with or without rotational transform) and arbitrarily anisotropic distribution functions are admitted. The stability condition requires that the drifts of the trapped particles be favourable, this depending on their pitch angles in general. If it is violated, then an electrostatic mode occurs that grows on the slow time scale of the guiding-centre drifts, thus conserving the longitudinal adiabatic invariant J. The present theory is an improvement and generalization of previous theories of the collisionless trapping instability in isotropic plasmas. It shows that anisotropy can have a stabilizing effect. It also shows that low-frequency interchange stability (J conserved) is a more restrictive requirement than interchange stability (J violated), and thus refutes the widely held opposite opinion. (auth) (UK)

17201 SKIN EFFECT IN TURBULENT Z DISCHARGES. Dubovoi, L. V.; Fedyakov, V. P.; Fedyakova, V. P. (Inst. of Electrophysical Instrumentations, Moscow). Zh. Eksp. Teor. Fiz.; 59: 1475-83(Nov 1970). (In Russian).

Results of experiments with pulsed z discharges characterized by anomalous values of the plasma conductivity in the skin-layer region are analyzed. It is shown that the peculiarities of behavior of powerful linear discharges and, in particular, of self-compressed z-pinches agree with the assumption that ion-acoustic microinstability is excited in the current layer of the discharges. (auth)

17202 INTERPRETATION OF AN EXPERIMENT ON INTERSTREAMING PLASMAS. Little, P. F.; Avis, B. E.; Turner, R. B. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Plasma Phys.; 12: 565-72(Aug 1970).

Observations on the potential fluctuations detected by a small external probe when two energetic plasma jets stream through each other were described previously. This was attributed to an ion–electron interstreaming instability. Here it is shown that the experimental values for the growth rate and the frequency range of the instability can be explained more accurately by the same theory if the local ion energy distribution is assumed to be different for ions of different energies. (auth) (UK)

17203 HYDROMAGNETIC PLASMA STABILITY CONDITIONS. Solov'ev, L. S. At. Energ. (USSR); 30: 14-20(Jan 1971). (In Russian).

A theory of hydromagnetic plasma stability is considered. It is shown that sufficient conditions of hydromagnetic stability, given by the stabilized effect of the magnetic well, may be satisfied for a number of closed configurations. General stability criteria of Rosenbluth–Longmire, Kadomtsev, and Mercier, and criteria suggested by the author are performed and compared. 25 references. (auth)

17204 INVESTIGATION OF INSTABILITIES OF PLASMA COLUMN IN TOKAMAK-3 DEVICE BY CORRELATION TECHNIQUES. Mirnov, S. V.; Semenov, I. B. At. Energ. (USSR); 30: 20-7(Jan 1971). (In Russian).

Results of measurements of spatial fluctuations of the discharge current magnetic field in the Tokamak-3 device are presented. The system of 18 magnetic probes at the external surface of a liner was used as transducers. By using of a balance system for subtraction of transducer signals with subsequent squaring and averaging, it is possible to observe at any moment of time a signal proportional to $1 - f(\varphi,\psi)$, where $f(\varphi,\psi)$ is the correlation function and φ, ψ are toroidal angular coordinates. Results of corresponding measurements for certain discharge regimes in the Tokamak-3 are presented. Assuming that the fluctuations are due to rotation of the plasma column with homogeneous distribution of the current density near the boundary, it is possible to correlate the appearance of these fluctuations with high mode number (m) MAD instabilities. In certain cases from measurements of the frequency spectrum of the observed fluctuations in the range 2 to 15 Mc, estimates of the rotation velocity of the plasma column can be made. (auth)

Thermonuclear Processes

17205 (AD–712692) ACCELERATION MECHANISM FOR NEUTRON PRODUCTION IN Z-PINCH DISCHARGES. Bernstein, Melvin J. (Aerospace Corp., El Segundo, Calif.). 21 Aug 1970. Contract F04701-70-C-0059. 32p. (TR–59(6220-50)-1; SAMSO-TR–70-365). NTIS.

A model was developed for the acceleration of deuterons in the tightly compressed column of a z-pinch discharge, in particular that of a plasma focus discharge. It was assumed that an annular current distribution undergoes a rapidly contracting transition to an axially peaked distribution, and the resulting crossed fields, B_θ and E_z, were used to calculate deuteron trajectories in the plasma. These results show how a significant number of ions can be accelerated to high energies and that they have a large value for their time-averaged axial velocities. The orbiting motion in the magnetic field produces an anisotropy distribution of collision velocities, and a neutron-production model based upon nuclear collisions by these deuterons accounts for the measured characteristics of neutron energies, neutron fluxes, and rates of neutron production. (auth) (USGRDR)

17206 (EUR-CEA-FC–463) MAGNETIC FLUX SINGULARITIES OBSERVED IN THE HARMONICA II MACHINE (1968 EXPERIMENTS). Ginot, P.; Plinate, P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov 1970. 65p. (In French). Dep. NTIS (U. S. Sales Only).

The Harmonica II machine was modified in order to improve the techniques for observing already-recorded singularities similar to the ones predicted by the Mercier theory on equilibrium. The new measurements confirm the earlier results and show that the mode of perturbation described by Mercier is dominant in the observed singularities. However, the identification is not yet certain. (auth) (France)

17207 (IYAF–8-70) SELECTION OF OPTIMAL PARAMETERS FOR STELLARATOR MAGNETIC SYSTEMS. Volosov, V. I.; Komin, A. V. (Akademiya Nauk SSSR, Novosibirsk, Institut Yadernoi Fiziki). 1970. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

The magnetic field in a stellarator is ordinarily created by two systems of windings. One creates a longitudinal, toroidal magnetic field. The other is a system of spiral windings consisting of n (n is equal to 2 or 3) pairs of helical conductors at an angle β to the axis of the torus. The plasma particles are bent around the axis of the torus in such a manner as to compensate for toroidal particle drift. The total bending angle at the perimeter is important in calculating plasma diffusion. If the bending angle varies with radius, the force lines at various radii are crossed. The magnitude of the crossing or width θ determines the stabilization of low-frequency, drift oscillations in the plasma. If it is assumed that the ratio of currents in the windings is chosen in an optimum fashion, geometrical factors such as the angle of inclination of the spiral windings to the axis of the torus and the ratio of the large and small radii of the torus can be varied in order to obtain maximum values of the width and bending angle. Equations are given to calculate these parameters, and the results are presented graphically. (TTT)

17208 (LA-tr-70-22) NEW SCHEME FOR A DOUBLE-TURN STELLARATOR. Preprint No. 31. Danilkin, I. S.; Shpigel, I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from report NP-18378. 24p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 45273. (M.O.W.)

17209 (UCRL-50002-70, pp 2,1-44) MAGNETIC MIRROR PROGRAM. (California Univ., Livermore. Lawrence Radiation Lab.).

From Controlled thermonuclear research.

Activities during the past year in the Magnetic Mirror Program included the final operation of two major experiments (2X and Baseball I), the approach to completion of construction of two new ones (2X II and Baseball II), and some highly encouraging developments in two areas of technology—high-flux ion sources and neutral beams, and high-efficiency direct conversion of charged-particle kinetic energy into electric power. Research is briefly reported on each. (M.O.W.)

17210 (UCRL-50002-70, pp 3,1-46) ASTRON PROGRAM. (California Univ., Livermore. Lawrence Radiation Lab.).

From Controlled thermonuclear research.

A summary of results for each of the following research topics is given: (1) fast magnetic probe measurements of the E-layer, (2) Astron trapping experiments, (3) E-layer neutralization, (4) observation of the hybrid mode, (5) E-layer losses at the time of the hybrid mode, (6) measurement of the radial density distribution of the E-layer by the detection of light emissions, (7) x-ray observations, (8) perturbation-coil experiments, and (9) calculation of Green's function for the Astron and its application to E-layer self-field measurements. (M.O.W.)

17211 (UCRL-50002-70, pp 6,1-22) ENGINEERING DEVELOPMENT. (California Univ., Livermore. Lawrence Radiation Lab.).

From Controlled thermonuclear research.

Mechanical engineering developments are described for the following: (1) magnetic mirror program, (2) Astron, (3) status of superconducting Levitron, and (4) technological aspects of controlled fusion reactors. Electronic developments for the above projects are mentioned. (M.O.W.)

17212 (UCRL-50944) TORMAG: A PROGRAM FOR SYMMETRY OPTIMIZATION OF TOROIDAL MAGNETS. Anderson, O. A.; Fuss, Dieter (California Univ., Livermore. Lawrence Radiation Lab.). 1 Oct 1970. 7p. Dep. NTIS.

The TORMAG code, which finds by a direct computation the optimum segment currents for low field ripple in a toroidal magnet with access gaps, is described. In a sample calculation, the code is applied to a T3A tokamak-geometry magnet. With three segments, field ripple is reduced from 4% to 0.1% without increasing the maximum current density or reducing access; the aspect ratio is actually improved to 4.4:1. TORMAG should be useful in the design of future strong-field machines, such as tokamaks or the proposed relativistic pinch machine. (auth)

17213 (UCRL-Trans-10497) CHARGE-EXCHANGE EXPERIMENT WITH A FAST PLASMA BUNCH IN THE I.N.E.S. INSTALLATION. Zamarashkin, L. V.; Kartashev, K. B.; Pistunovich, V. I.; Platonov, V. V.; Filimonova, E. A. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). Translated by T. Watt for Univ. of California, Lawrence Radiation Lab., Livermore, from report IAE-1951. 66p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 23732. (M.O.W.)

17214 PROSPECTS OF FUSION POWER. Gough, William C.; Eastlund, Bernard J. Sci. Amer.; 224: No. 2, 50-64(Feb 1971).

The role of energy in mankind's future needs is discussed. Recent developments in the controlled fusion research program are outlined. Fusion reactor power plant designs and timetables are described. (M.O.W.)

17215 STUDY OF THE COAXIAL PLASMA ACCELERATOR. Tsuda, Hiroshi; Ota, Kozo; Kato, Ryozo; Tanahashi, Mitsuru (Doshisha Univ., Kyoto). Doshisha Daigaku Rikogaku Kenkyu Hokoku; 10: 205-18(Nov 1969). (In Japanese).

An experimental study was conducted on coaxial plasma accelerators for the purpose of understanding the acceleration mechanism of the accelerators and the structure of electromagnetic shock waves. According to measurements with magnetic probe, electric probe, photomultiplier, and piezoelectric detector, the following results were obtained. The current in the accelerator takes a form of a sheet for the initial several microseconds, and a circular current is generated in the annulus in the first discharge cycle. The luminous front and the shock follow the current sheet successively. Electron temperature of decayed plasma emitted from the accelerator is about $10^5 \sim 4 \times 10^4$ °K and electron density is nearly $10^{14} \sim 10^{13}$ (cm^{-3}). The velocity of the current sheet can be accounted for by the "snowplow model" with some assumptions. (auth) (Japan)

17216 STUDY OF A COAXIAL PLASMA ACCELERATOR. Rhee, Moon-jhong. Washington, D. C.; Catholic Univ. of America (1970). 50p. University Microfilms Order No. 70-22,705.

Thesis.

It has been known for sometime that the propagating current sheet in a coaxial plasma accelerator behaves differently according to its electrode polarity arrangement. However, most of the previous analyses only deal with the case where the center electrode is of positive polarity. An analysis is made in order to obtain the shape and velocity relation of the current sheet. The model upon which the theory is based includes a consideration of the charged-particle flow and an assumption of negligible cathode electron emission. The velocity is directly derived from the model and the shape of the current sheet is obtained by solving the steady-state fluid equations. It is found that the shape and velocity are dependent on the electrode polarity of the coaxial electrodes and on the species of working gas used. In order to deal with more realistic situations in the coaxial accelerator operation, the model is combined with an effect due to a neutral particle flow immediately ahead of the current sheet (compound model). The various shapes and the velocities of current sheet obtained with the compound model are compared with available experimental data and good agreements are found. (Diss. Abstr. Int., B)

17217 RECENT DEVELOPMENT IN CONTROLLED NUCLEAR FUSION RESEARCH. Yamato, Harumi (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Oyo Butsuri; 39: 951-60 (Oct 1970). (In Japanese).

Recent developments in the controlled nuclear fusion research are summarized. After giving some insights into the feature of the D-T steady-state reactor, plasma confinement problems are discussed in three magnetic field geometries. In a low-beta plasma, the most remarkable progress is shown in axisymmetric toruses. In an inner-conductor torus, stable plasmas are confined for the time of ideal magnetic confinement, that is, classical diffusion time and in a tokamak, the highest temperature and density are achieved as a torus. Stable confinement is also obtained in high-beta plasmas in linear theta-pinch geometries. In order to prevent end losses, theta-pinch experiments in toroidal geometries are now under way. The same order of densities and temperatures as low-beta torus is achieved in mirror devices, and after suppression of microinstabilities, the remaining problem is to overcome the collisional end losses. (auth) (Japan)

17218 FINAL REPORT OF THE IAEA PANEL ON INTERNATIONAL COOPERATION IN CONTROLLED FUSION RESEARCH AND ITS APPLICATION. Nucl. Fusion; 10: 414-21(Dec 1970).

The objectives and present status of fusion research are first surveyed. Specific systems and concepts are then reviewed, along with technological developments required, common problems, and problems related to specific systems. Finally, an estimation of efforts, costs, and the time scale is presented, along with recommendations for future work. (M.O.W.)

Wave Phenomena

Refer also to abstracts 17002, 17008, 17011, 17130, 17169, and 17199.

XUM

17219 (CTS-741) COMPENSATION OF RESONANCE PERTURBATIONS OF A STELLARATOR MAGNETIC FIELD. Ivanovskii, M. A.; Popryadukhin, A. P. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated by J. B. Sykes (Culham Lab., Abingdon, Eng.), from report NP-18477. 16p. Dep. NTIS (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 24: 51729.

17220 (CU-3954-7) NUMERICAL STUDIES OF ION-ACOUSTIC COLLISIONLESS SHOCKS AND SOLITARY WAVES. Sakanaka, Paulo H. (Columbia Univ., New York. Plasma Lab.). 1970. Contract AT(30-1)-3954. 111p. Dep. NTIS.

A numerical technique to solve the Vlasov–Poisson system of equations for ions with isothermal electron fluid was developed and tested. The phase-space grid points are assigned values of the ion distribution function. These values are moved along ion trajectories by the self-consistent electric field, and are reassigned to four grid points of the phase-space cell in which they fall, by an appropriate area-sharing method. Poisson's equation is solved by an iteration method or the Runge–Kutta method. The technique was applied to study the formation and the evolution of ion-acoustic collisionless shocks and solitary waves in a plasma with a high electron–ion temperature ratio. (auth)

17221 (D-1-82-1010) SOME ALGEBRAIC SOLUTIONS OF THE CYCLOTRON RESONANCE INTERACTION. Ho, H. S.; Liemohn, H. B. (Boeing Scientific Research Labs., Seattle, Wash. Environmental Sciences Lab.). Sep 1970. 35p.

The cyclotron-resonance interaction between electromagnetic waves and nonthermal plasmas was investigated for Cauchy (resonance) velocity distributions that yield algebraic dispersion equations. Combinations of anisotropic and streaming distributions were considered for ions and electrons to ascertain the relative importance of the interaction at different frequencies. Distribution forms and parameter ranges were chosen which would simulate possible conditions in the magnetosphere and solar wind. Because the equations are algebraic, the valid characteristic roots are readily identified, and their unstable nature is determined by conventional convective/nonconvective criteria. Parameter regimes of spatial amplification (convective instability) and temporal growth (nonconvective instability) were identified. Amplitude exponents are presented as a function of frequency for several cases of interest, and algebraic expansions are derived. On the basis of the cases studied, it is concluded that the cyclotron-resonance interaction is a convective instability for parameter values appropriate for the undisturbed magnetosphere and solar wind. Nonconvective instabilities are only obtained for relatively large streaming conditions that may be encountered in laboratory or stellar applications. (auth)

17222 (ORO-3871-5) QUASISTATIC ION CYCLOTRON WAVE STUDIES. Final Report. Swanson, D. G. (Texas Univ., Austin). 15 Nov 1970. Contract AT(40-1)-3871. 16p. Dep. NTIS.

Quasi-static ion cyclotron waves in plasmas with electron densities of the order of $10^{20}/m^3$ to $10^{21}/m^3$ (10^{14} to 10^{15}/cc) were studied. This study demonstrated the possibility of using these waves to heat plasmas at harmonics of the ion cyclotron frequency at low densities. The effect of collisions was examined. (M.O.W.)

17223 (SU-IPR-396) NOTE ON APPLICATION OF WHITHAM'S METHOD TO NONLINEAR WAVE INTERACTION IN DISPERSIVE MEDIA. Dysthe, K. B. (Stanford Univ., Calif. Inst. for Plasma Research). Nov 1970. Contract AT(04-3)-799. 23p. Dep. NTIS.

A method, developed by Whitham for obtaining equations governing the slow variation of finite amplitude wavetrains, is modified and applied to the study of nonlinear interaction of waves in a dispersive medium. The relevant equations describing the slow variation of the interacting waves are derived. An equation describing the so-called "self-action" effect of a finite-amplitude wave is also derived, and as an application, the stability of such a wave is studied. (auth)

17224 WAVES AND OSCILLATIONS IN INHOMOGENEOUS PLASMAS UNDER THE INFLUENCE OF EXTERNAL ELECTRIC FIELDS. Taub, Samuel Jonathan. Brooklyn; Polytechnic Inst. (1970). 103p. University Microfilms Order No. 70-26,112.

Thesis.

A self-consistent solution of the linearized Vlasov–Poisson equations was obtained for a one-dimensional, inhomogeneous, unmagnetized plasma. The only restriction on the equilibrium density is that it vary slowly on the scale of the average Debye length. It is assumed that the equilibrium electron distribution is locally Maxwellian, but the method can be generalized to other velocity distributions. The ions are considered to be a fixed, uniform background charge. The solution is valid to first order in B^{-1}, where B is the ratio of the square of the length over which the density varies significantly, to the square of the average Debye length. A wave equation for the electric field of an unbounded plasma was obtained. This field is a result of some small perturbation of the plasma, and the Landau damping rate of the waves is given explicitly in terms of this field. The equation for the electric field can be extended to give the eigenvalue equation for a bounded plasma, where the eigenvalues are the squares of the Tonks–Dattner resonant frequencies. The effect of a driving, time dependent, electric field is treated. A self-consistent solution to the Vlasov–Poisson equations for the electric field and the Landau damping rate is given. The effect of an external, driving, electric field on a bounded plasma is considered. A self-consistent solution is obtained for the electric field and the Landau damping when the driving frequency is equal to one of the Tonks–Dattner resonant frequencies. Calculations are performed using an IBM 360/50 computer. The Landau damping rate and the self-consistent electric field corresponding to the resonant frequencies are calculated. (Diss. Abstr. Int., B)

17225 EXCITATION AND SPATIAL RESPONSE OF ION-ACOUSTIC WAVES. Jacob, Jonah Hye. New Haven; Yale Univ. (1970). 195p. University Microfilms Order No. 70-25,285.

Thesis.

The coupling to ion-acoustic waves by a three-dimensional ballistic ion source is investigated in detail. The ion beam is generated by a fine meshed (i.e., the mesh size is smaller than the electron Debye length), negatively biased, multigrid transducer. For weakly damped waves, one finds the coupling is strongly dependent on the symmetry of the source electric field. For an odd symmetric-source electric field, the coupling is much stronger than for an even-symmetric source electric field. In the case of good symmetry (odd source electric field) the response of the plasma to such excitation is characterized by a Fresnel-like interference in the near field. In spite of the complications of three-dimensionality and finite sources, for sufficiently strong damping, the linear dispersion relation can be unfolded. Landau damping and the theoretically predicted cutoff at the ion plasma frequency were observed. (Diss. Abstr. Int., B)

17226 INTERACTION OF WAVES IN PLASMA DENSITY GRADIENTS. Boulanger, Philippe. Boulder, Colo.; Univ. of Colorado (1970). 205p. University Microfilms Order No. 70-23,689.

Thesis.

The solutions of the classical Vlasov equation are derived for an inhomogeneous plasma in different cases to calculate either the longitudinal wave excited by a transverse wave striking a density gradient or the transverse wave excited by a longitudinal in similar circumstances. Several methods are used depending on the type of density gradients considered. The problem of wave creation for large and sharp density gradients is solved assuming a plasma–vacuum interface and a specular reflection condition for the electrons. The results obtained reduce to those obtained by Landau who considered a one-dimensional problem with a longitudinal wave in vacuum. (TSS) (Diss. Abstr. Int., B)

17227 EFFECT OF COLLISIONS ON RESONANT THREE-WAVE INTERACTION. Stenflo, L. (Inst. of Physics, Uppsala). Plasma Phys.; 12: 509-18(Jul 1970).

The nonlinear resonant interaction between three monochromatic longitudinal plasma waves is studied by means of a kinetic approach. BGK and Fokker–Planck collision models are introduced in order to make it possible to treat effects of collisions. The coupling coefficients are calculated by means of a normal-mode analysis. (auth) (UK)

17228 INTERESTING PROPERTY OF THE COEFFICIENTS OF THE DISPERSION EQUATION IN A PLASMA SYSTEM. Fung, P. C. W. (Stanford Univ., Calif.). Plasma Phys.; 12: 503-8(Jul 1970).

It is shown that the synchrotron radiation emissivity function is contained in the coefficients of the dispersion equation describing the propagation of plane waves in a magnetoactive plasma of general momentum distribution. (auth) (UK)

17229 CONNECTION BETWEEN SELF-EXCITED LOW FREQUENCY OSCILLATIONS AND ANOMALOUS PLASMA DIFFUSION. Noon, J. H.; Schmidt, H. A.; Holt, E. H. (Rensselaer Polytechnic Inst., Troy, N. Y.). Plasma Phys.; 12: 477-88(Jul 1970).

By varying either the background pressure or the magnetic field strength at the cathode of an argon gas-fed hollow-cathode arc, it is possible to suppress a low-frequency coherent insta-

bility identified as an ion-acoustic wave. An operating regime for this highly ionized plasma source is found where the rate of plasma diffusion across the magnetic field is classed as anomalous. This behavior is associated with a large amplitude of the ion-acoustic wave, but not with plasma turbulence or a drift wave. Electrode sheath conditions and the phase difference between the density and potential perturbations are shown to be more important in regard to the plasma losses than the steady-state plasma parameters in the region of the plasma in which observations are made. (auth) (UK)

17230 MOTION OF CHARGED PARTICLES IN A SELF-CONSISTENT CONTINUOUS SPECTRUM OF WAVES. **Best, R. W. B.** (EURATOM–FOM, Jutphaas, Netherlands). Physica; 48: 561-70(30 Sep 1970).

The equations of Vlasov and Poisson describing one-dimensional plasma motion are solved. The self-consistent potential assumed consists of a broad spectrum of traveling waves. The solution to be derived first involves expansions in the spectral amplitude. At first order, the linear dispersion relation, including spatial Landau damping, is recovered. The second order, which shows no secularity, yields coefficients of the series for the potential. They are expressed in terms of the distribution function, which is assumed as a function of one constant of motion only, obtained by integrating once the equation of motion. The solution holds valid for a half-space. Combining two of the above solutions, the velocity of a particle through the entire space is derived when it passes through a local disturbance described by a broad spectrum of undamped traveling waves. The mean velocity here changes slightly by resonant interaction, which provides a mechanism for the above-mentioned Landau damping. (auth)

17231 PARAMETRIC EXCITATION OF A PLASMA. **Chen, C. S.; Lewak, G. J.** (Univ. of California, San Diego, La Jolla). J. Plasma Phys.; 4: 357-69(May 1970).

The parametric effect of an applied uniform oscillating electric field on both unmagnetized and magnetized plasmas is investigated. By using a perturbation method of multitime scales, it is shown that parametric excitation of transverse waves propagating obliquely to the applied field in an unmagnetized plasma is possible. The growth rate of the excited waves reaches a maximum for transverse propagation. Ion motion does not change the character of the parametric excitation except by reducing the growth rate. In a magnetized plasma it is shown that excitation of a pair of waves is possible where one is a Langmuir wave, propagating along the magnetic field and the other is a circularly polarized transverse wave propagating in the opposite direction. (auth) (UK)

17232 GROWING PLASMA OSCILLATIONS FOR SYMMETRICAL DOUBLE-HUMPED VELOCITY DISTRIBUTIONS. **Cowley, S. W. H.** (Imperial Coll. of Science and Tech., London). J. Plasma Phys.; 4: 297-300(May 1970).

The problem considered is that of growing longitudinal waves that propagate in a hot plasma parallel to any magnetic field that may be present (i.e., the magnetic field is neglected in the Vlasov equation). The necessary and sufficient condition for stability was obtained by Penrose (1960) and growth rates for plasmas obeying a Maxwell zero-order velocity distribution were computed by Fried & Conte (1961). It is shown that, for any symmetrical double-humped velocity distribution, all growing waves with real wave number have phase velocity equal to the velocity at the minimum of the distribution. Distributions made up of parabolae are convenient for calculation, and growth rates are obtained for several symmetrical distributions made up of parabolae. (auth) (UK)

17233 ENHANCED DAMPING OF LARGE-AMPLITUDE PLASMA WAVES. **Nakamura, Yoshiharu** (Tokyo Univ.); **Ito, Masataka.** Phys. Rev. Lett.; 26: 350-3(15 Feb 1971).

The collisionless damping of small-amplitude plasma waves is independent of the exciting voltage V_{ex}. For large-amplitude waves, the damping rate increases linearly with V_{ex} and amplitude oscillations are observed. A phase transition appears at amplitude minima. (auth)

17234 CYCLOTRON HARMONIC WAVE PROPAGATION AND INSTABILITIES. I. PERPENDICULAR PROPAGATION. **Tataronis, J. A.; Crawford, F. W.** (Stanford Univ., Calif.). J. Plasma Phys.; 4: 231-48(May 1970).

A comprehensive picture is presented of longitudinal wave propagation in a warm homogeneous magnetoplasma. Computed dispersion characteristics for propagation perpendicular to the static magnetic field are discussed. For a ring electron velocity distribution it is found that mode coupling and absolute instability can occur. Similar effects are predicted for a spherical shell distribution. The Maxwellian distribution gives rise to stable propagation of undamped waves and attenuating standing waves. A mixture of ring and Maxwellian distributions can give absolute instability with stronger growth and lower instability thresholds than for the ring distribution alone. (auth) (UK)

17235 CYCLOTRON HARMONIC WAVE PROPAGATION AND INSTABILITIES. II. OBLIQUE PROPAGATION. **Tataronis, J. A.; Crawford, F. W.** (Stanford Univ., Calif.). J. Plasma Phys.; 4: 249-64(May 1970).

The ring and Maxwellian transverse velocity distributions, which are absolutely unstable and stable, respectively, for perpendicular propagation, are shown here to be both absolutely unstable for oblique propagation. Their instabilities are radically affected by the introduction of axial velocity spread. A detailed study is made for the cases of a Maxwellian transverse distribution with resonance and resonance-squared axial-velocity distributions. It is shown that absolute instabilities occur at high energy anisotropies. These become convectively unstable as the anisotropy is reduced, and are quenched as isotropy is approached. The isotropic Maxwellian is treated in detail, and shows both cyclotron and Landau collisionless damping. (auth) (UK)

17236 INTERACTION OF WAVES IN PLASMA WAVEGUIDES. I. **Karplyuk, K. S.; Kolesnichenko, Ya. I.** (Inst. of Physics, Kiev). Ukr. Fiz. Zh.; 15: 1459-67(Sep 1970). (In Russian).

The interaction of waves is considered in a bounded plasma described by the two-liquid hydrodynamic equations with regard for plasma temperature finiteness. It is shown that with a corresponding determination of scalar product, normal modes of the plasma waveguide form an orthogonal system. This fact enables one to calculate matrix elements describing wave-interaction processes in plasma waveguides. Some concrete interactions with participation of both volume and surface waves are considered in the case of no magnetic field. (auth)

17237 INTERACTION OF WAVES IN PLASMA WAVEGUIDES. II. **Karplyuk, K. S.; Kolesnichenko, Ya. I.** (Inst. of Physics, Kiev). Ukr. Fiz. Zh.; 15: 1468-76(Sep 1970). (In Russian).

A nonlinear interaction of waves in plasma waveguides immersed in a magnetic field is investigated. Matrix elements describing interaction of slow hf waves are calculated. Some decay instabilities in plasma waveguides are considered. (auth)

17238 RF CHARACTERISTICS OF A PLANE-GRID CAPACITOR IMMERSED IN A HOT COLLISION-FREE PLASMA WITH UNIFORM MAGNETIC FIELD PARALLEL TO THE GRID PLATES. **Buckley, R.** (Radio and Space Research Station, Slough, Eng.). pp 129-58 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

A particular boundary-value problem involving Bernstein modes is considered. A plane grid capacitor is immersed in a hot (Maxwellian) collisionless plasma and is excited by an rf voltage of frequency high enough to justify neglect of ion response. There is a steady uniform magnetic field parallel to the plane of the grids. The electric field in the plasma is computed as a function of distance from the grids and rf admittance of the grid/plasma system is computed as a function of frequency for various values of the grid separation. Computations are restricted to the case $\omega_p = 2\omega_B$, where ω_p and ω_B are the electron plasma and gyro frequencies respectively. For this case, a complete set of results for $\omega < 5\omega_B$ is presented. (M.O.W.)

17239 RADIATION FROM AN ELECTRIC DIPOLE IN AN AXIALLY MAGNETIZED PLASMA COLUMN: EXCITATION OF DIPOLAR RESONANCES. **Yip, G. L.** (McGill Univ., Montreal). pp 183-97 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

The problem of a point electric dipole situated on, and oriented parallel to, the axis of an axially magnetized plasma column to simulate an antenna radiating through a plasma sheath was studied earlier. Advantage was taken of the geometry of the problem to base the analysis on cylindrical waves. It was found that the application of a suitable magnetostatic field results in a significant improvement in the power and radiation resistance of the electric dipole. The case was studied here in which the dipole is oriented perpendicular to the magnetostatic field, and the improvements in transmission in these two cases were compared. (M.O.W.)

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17240 OBSERVATIONS OF LANDAU DAMPING IN A PLASMA-CYCLOTRON-WAVE INTERACTION EXPERIMENT. Mueller, G. (Institut fuer Plasmaphysik, Garching, Ger.). pp 271-83 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

Plasma cyclotron wave coupling, which leads to the generation of unstable quasi-static waves with frequencies $\omega_e/2$ and harmonics of $\omega_e/2$, was studied in a symmetric counterstreaming double electron beam system in a uniform magnetic field. It was shown that the upper limit of the B field at which the excitation of the waves stops must be explained in terms of a collisionless Landau damping effect. (M.O.W.)

17241 GRID ASSEMBLIES AS ELECTROSTATIC PLASMA WAVE ANTENNAS. Simonen, T. C. (Institut fuer Plasmaphysik, Garching, Ger.). pp 285-96 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

Driving-point and trans-impedances for a Maxwellian electron plasma were numerically computed in order to assess single-pole impedance approximations in the heavy Landau damping regime $\omega > 1.3\ \omega_p$. Within the range of parameters investigated, $1.3 \leq \omega/\omega_p \leq 2.0$ and $5 \leq 1/\lambda_D \leq 100$, simple impedance approximations based on the fundamental Landau pole k_l were found to have an accuracy of 2% or better. The free-streaming signal, exp(−const. $1^{\frac{1}{2}}$), was found to be heavily overshadowed by the stronger, more slowly decaying, circulating ground current signal. However, at close range, even if Landau damping is strong, the electron plasma wave transmitted between grid assemblies has an exponential dependence exp(ik,l). (M.O.W.)

17242 WAVE PACKETS IN A HOT INHOMOGENEOUS PLASMA. Houghton, M. J. (Plasma Physics Lab., Culham, Eng.). pp 443-6 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

An attempt was made to find equations governing whistler-mode wave and wave-packet propagation in a hot collisionless plasma immersed in a given nonuniform ambient magnetic field. The method for finding solutions is outlined. (M.O.W.)

17243 SOME STUDIES OF WHISTLER INSTABILITY. Crawford, F. W.; Lee, J. C.; Tataronis, J. A. (Stanford Univ., Calif.). pp 447-69 of Plasma Waves in Space and in the Laboratory. Vol. 2. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.2).

Results are presented of an extensive series of computations on variations of the basic case of a gyrating electron beam interacting with a cold background plasma. Only propagation parallel to the magnetic field is considered. The dispersion relation is presented for a Maxwellian plasma penetrated by an electron beam with both longitudinal and transverse energy spread. Numerical solutions for several limiting cases of this dispersion relation are examined. (M.O.W.)

17244 ENERGY TRANSFER OF A WAVE PACKET IN A WEAKLY INHOMOGENEOUS MEDIUM: WKB APPROXIMATION. Jungwirth, K. (Inst. of Plasma Physics, Prague). Plasma Phys.; 12: 737-40(Oct 1970).

It is shown that the physical assumptions applied in the local theory to deriving expressions for the energy density, the energy flux density and the energy dissipation density of a wave packet are sufficient for generalizing these expressions to be applicable during the whole period of validity of the WKB approximation for the packet under investigation. Further, it is shown that besides the actual growth rate, the "local" growth rate (depending on spatial co-ordinates) has also a useful physical interpretation for the waves studied. It determines the part of the wave energy density that is dissipated or transformed from the medium to the wave per unit time in a unit volume. (auth) (UK)

17245 ACOUSTIC INSTABILITIES OF A BEAM OF TRANSVERSE ELECTROMAGNETIC WAVES IN A PLASMA. Makhan'kov, V. G.; Tsytovich, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Plasma Phys.; 12: 741-9(Oct 1970).

Low-frequency (lf) instabilities of a beam of transverse waves in a plasma are investigated for the case in which the frequencies of the instabilities are less than the effective collision frequency ν_e. It is shown that the energy losses of the beam (whole frequency $\omega_l \gg \omega_{pe}$) due to excitation of these instabilities can increase and exceed the usual Joule dissipation. The growth rates for the lf instabilities are presented for various cases. (auth) (UK)

17246 STUDIES OF NONLINEAR RESONANCE CONDITIONS FOR THREE-WAVE INTERACTIONS IN A PLASMA. Hoeijer, S. (Research Inst. for National Defence, Stockholm); Wilhelmsson, H. Plasma Phys.; 12: 585-98(Aug 1970).

The possibilities of fulfilling the conditions for resonant three-wave interactions in a plasma are investigated. The interacting waves are allowed to have general directions of propagation. A constant magnetic field is present in the plasma, which is furthermore assumed to have a nonzero temperature and a homogeneous distribution of electrons. Ion motions as well as effects of collision are neglected. The approach to the problem is hydromagnetic. Resonances are determined and interpreted in some numerically studied cases. (auth) (UK)

17247 ELECTROSTATIC SURFACE WAVES IN ADJACENT PLASMA STREAMS. El-Naggar, I. A.; Pakhomov, V. I. (Atomic Energy Establishment, Cairo). Plasma Phys.; 12: 599-610(Aug 1970).

High-frequency electrostatic surface waves at the plane boundary between adjacent cold plasma streams are investigated. The dispersion equation is derived and investigated. In the case for which one stream density is small, expressions are obtained for growth rates of instability under the Cherenkov and cyclotron conditions. (auth) (UK)

17248 CYCLOTRON OSCILLATIONS IN AN INHOMOGENEOUS MAGNETIC FIELD. Timofeev, A. V.; Klopovskii, K. S. (Inst. of Atomic Energy, Moscow). Plasma Phys.; 12: 611-25(Aug 1970).

Cyclotron oscillations of a tenuous plasma with a nonequilibrium ion velocity distribution are discussed. It is shown that even a slight inhomogeneity of the magnetic field may lead to the elimination of a certain class of unstable characteristic oscillations, even though a treatment in the "local quasi-classical" approximation predicts instability for this case. The Laplace transform method is used to determine the evolution of the initial perturbations. It is found that the perturbations grow for a certain time, with a growth rate that can be calculated from the local theory, and then are rapidly damped. (auth) (UK)

17249 WAVE PROPAGATION IN COLD PLASMA IN THE PRESENCE OF THE CORIOLIS FORCE. Uberoi, C.; Das, G. C. (Indian Inst. of Science, Bangalore). Plasma Phys.; 12: 661-84(Sep 1970).

A detailed study was made of wave propagation in a rotating cold plasma including the Coriolis force. Wave propagation modes in the absence and presence of an external magnetic field parallel to the axis of rotation as well as of collisions are considered in turn. Dispersion relations for waves propagated along the axis of rotation indicate that the transverse right-circularly polarized wave has no resonance while the left-circularly polarized wave has one in the absence of magnetic field ($H = 0$); for $H \neq 0$ and when the frequency of the wave is less than twice the rotational frequency ($\omega_{ce} < 2\Omega$) the left-circularly polarized wave has two resonances while the right-circularly polarized wave still has none, while for ($\omega_{ce} > 2\Omega$) both waves have one each. More significantly, it is found that rotation introduces a new cut-off and therefore a new stop-band for the left-circularly polarized wave. For the extraordinary wave, which is neither purely transverse nor purely longitudinal, propagated transverse to the magnetic field (and to the axis of rotation), there are three cut-off frequencies and two resonances in the presence of the Coriolis force. There is a change in the relative location of resonances and cut-offs with increasing rotational frequency, apart from the change in the widths of the stop bands, also characteristic of the right- and left-circularly polarized waves. This has the important implication that in the second and third propagating regions the extraordinary wave is a backward wave for certain frequencies near the stop band. Characteristic variation of the refractive index and the absorption coefficient with rotational frequency is also found. (auth) (UK)

17250 NONLINEAR INTERACTIONS OF COHERENT ELECTROSTATIC PLASMA WAVES. Dysthe, K. B. (United Kingdom Atomic Energy Authority, Abingdon, Eng.); Franklin, R. N. Plasma Phys.; 12: 705-21(Sep 1970).

Nonlinear processes leading to growth and decay of coherent electron plasma waves are examined. Particular consideration is given to (a) the three-wave resonant interaction involving two electron waves and an ion wave, (b) parametric generation by a single large amplitude electron wave, and (c) nonlinear Landau damping due to wave–wave–particle interaction. Computed results are given for the ion wave amplitude in (a), the threshold

level in (b), and the damping and growth of the waves in (c), the ratio of electron to ion temperature being taken as a parameter. The implications of these results for the design of experiments to observe the effects are discussed. (auth) (UK)

17251 AXIALLY SYMMETRIC WAVES IN A VACUUM CHANNEL IN PLASMA. Pakhomov, V. I.; Rizk, H. M. (Atomic Energy Establishment, Cairo). Plasma Phys.; 12: 723-6(Sep 1970).

Axially symmetric electromagnetic waves are considered in a vacuum channel with an external parallel magnetic field in an unbounded cold plasma. The results of the investigation of the dispersion equation for the fast H waves and fast E waves are illustrated and discussed. The behavior of slow E waves and slow H waves is deduced and discussed. It is confirmed that, for a very strong external magnetic field, the propagation of electromagnetic waves along the channel is impossible. (UK)

Shielding

Refer also to abstracts 15850, 17165, and 17670.

17252 (AD-710985) RADIATION ENVIRONMENT ABOVE AN AIR/GROUND INTERFACE COVERED WITH ^{60}Co. Carter, Robert E. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Jan 1968. 39p. (AFRRI-SR-68-1). NTIS.

A review was made of experimental and theoretical determinations of the buildup factor 3 feet above an infinite air/ground interface uniformly covered with ^{60}Co. Experimental values of the buildup factor range from 1.15 to 1.38 and theoretically calculated values range from 1.15 to 1.23. A new series of Monte Carlo calculations is reported that tests various hypotheses which could account for this range of uncertainty. It is concluded that the substitution of compressed air or water for soil (required in the theoretical method of moments) is valid and that any intrinsic differences between the moments method and Monte Carlo techniques can account for no more than a 2% difference in the estimation of the buildup factor. A best value of 1.21 ± .02 may be assigned to the buildup factor 3 ft above an infinite air/ground interface contaminated with ^{60}Co. Angle and energy distributions of the photon number flux density for this geometry are also presented. (auth) (USGRDR)

17253 (AD-711839) TIME-DEPENDENT FAST-NEUTRON AND SECONDARY GAMMA-RAY SPECTRUM MEASUREMENTS IN CONCRETE. VOLUME I. Final Report, March 1, 1968–November 15, 1969. Harris, L. Jr.; Kendrick, H.; Naliboff, Y. D.; Sperling, S. M. (Gulf General Atomic, Inc., San Diego, Calif.). 17 Nov 1969. Contract DASA01-68-C-0097. 253p. (GA-9751(Vol.1); DASA-2401-1). NTIS.

An experimental method was developed for studying simultaneously fast-neutron transport and secondary gamma-ray production and transport in shields. An electron linear accelerator (Linac) was used to produce intense 50-nsec pulses of photoneutrons. These neutrons streamed down an evacuated 52-meter-long drift tube to strike concrete slabs up to 40 in. thick. A 5 in. by 5 in. cylindrical NE-213 scintillator was positioned behind the concrete slabs to detect both fast neutrons and secondary gamma rays produced in the concrete by (n,xγ) and (n,γ) reactions. Three parameters: time, pulse-height, and neutron/γ-ray identification were recorded for each detection event. Fast neutrons and γ rays produced by (n,xγ) reactions were recorded for times 0.87 to 2.84 μsec (corresponding to incident neutron energies 1.8 to 20 MeV). Capture γ rays were detected for times up to 1500 μsec after the Linac pulse. Pulse-height spectra were binned according to time for neutrons and γ rays. Then, for each time interval, these pulse-height spectra were unfolded to produce time-dependent fast-neutron ($2.0 < E < 20$ MeV) and γ ray ($0.8 < E < 9.0$ MeV) energy spectra. Thirty-group P3S16 (Lobatto) 1DF neutron transport calculations were performed, and results were compared with measured leakage neutron energy spectra. (USGRDR)

17254 (AD-711840) TIME-DEPENDENT FAST-NEUTRON AND SECONDARY GAMMA-RAY SPECTRUM MEASUREMENTS IN CONCRETE. VOLUME II. Final Report, March 1, 1968–November 15, 1969. Harris, L. Jr.; Kendrick, H.; Naliboff, Y. D.; Sperling, S. M. (Gulf General Atomic, Inc., San Diego, Calif.). 17 Nov 1969. Contract DASA01-68-C-0097. 477p. (GA-9751(Vol.2); DASA-2401-2). NTIS.

For abstract, see abstract for Part I, AD-711839, preceding. (M.H.R.)

17255 (JINR-P1-5482) CROSS SECTION OF THE ELECTRON-POSITRON PAIR PRODUCTION BY γ-QUANTA WITH THE ENERGY FROM 35 TO 2000 MeV IN LIQUID XENON. Dworakowski, M.; Slowinski, B.; Strugalski, Z.; Janowska, B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1970. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

Cross sections of the electron–positron pairs produced by γ-quanta with the energy from 35 to 2000 MeV in liquid xenon were determined experimentally. The analysis of the results is given. (auth)

17256 (LA-4575) TRANZIT: A PROGRAM FOR MULTIGROUP TIME-DEPENDENT TRANSPORT IN (ρ,z) CYLINDRICAL GEOMETRY. Lathrop, K. D.; Anderson, R. E.; Brinkley, F. W. (Los Alamos Scientific Lab., N. Mex.). Dec 1970. Contract W-7405-eng-36. 32p. Dep. NTIS.

Finite difference equations are derived for the time-dependent Boltzmann equation in (ρ,z) geometry. Generalized weighted-diamond difference equations are used to provide recursive solution of the difference equations. A formulation is given for a first collision source due to an energy-distributed point source on the axis of a system with material properties nonuniform in the z direction. The TRANZIT program to solve the difference equations and (optionally) evaluate the uncollided flux is described. Input and usage instructions for the program are given. Comparisons of calculations with Monte Carlo results are made and used to illustrate typical problem output. (auth)

17257 (NIRS-9, pp 1-14) PHYSICAL SCIENCES. (National Inst. of Radiological Sciences, Chiba (Japan)).

From Annual Report, 1969–1970.

Developments are reported for studies on: scattering and energy loss of 5 to 30 keV electrons in thin films; consistency of physical term used in high energy x-ray therapy through the concept of source peak depth distance; scintillation camera based on delay line time conversion; an approach to optimal data processing of radioisotope images; attenuation of monoenergetic neutrons in Pb, Fe, ordinary concrete, heavy concrete, H_2O, and paraffin; estimation of genetically significant dose from occupational exposure in Japan; multi-loaded metal salt ion exchange resins zirconium phosphate, nickel ferrocyanide anion exchange resin; and ion exchange adsorption of radionuclides by ferrocyanide molybdate. (W.H.K.)

17258 (ORNL-RSIC-29) A REVIEW OF THE MONTE CARLO METHOD FOR RADIATION TRANSPORT CALCULATIONS (COLLECTED PAPERS OF A SEMINAR, OCTOBER 5–7, 1970). Maskewitz, Betty F.; Jacobs, Vivian Z. (comps.) (Oak Ridge National Lab., Tenn.). Feb 1971. Contract W-7405-eng-26. 153p. (CONF-701020). Dep. NTIS.

This review consists of 18 papers presented at the Monte Carlo Seminar–Workshop held at Oak Ridge, Tennessee, October 5–7, 1970. They constitute a current statement of the state-of-the-art of the Monte Carlo method as used to calculate radiation transport and establish the fact that only this method of solving the Boltzmann transport equation is routinely applied to three-dimensional problems. Several computer codes utilizing the Monte Carlo method were reported. These include: POKER(CEA), ANDY, MCNA and MCP (LASL), FASTER (ART), ANTE (MAGI), ESP and MORSE (ORNL). Currently, FASTER, ANTE and MORSE are available in the Radiation Shielding Information Center for routine distribution. It is expected that others may be included in the near future. (auth)

17259 ELECTRON TRANSMISSION MEASUREMENTS FOR Al, Sn, AND Au TARGETS AT ELECTRON BOMBARDING ENERGIES OF 1.0 AND 2.5 MeV. Rester, D. H. (Ling-Temco-Vought, Inc., Dallas); Derrickson, J. H. J. Appl. Phys.; 42: 714-21(Feb 1971).

Total transmitted electron energy spectra were constructed from measurements of electron energy spectra at various emission angles for targets of Al and Au of thicknesses of from 0.2 to 0.6 of the range in these materials. Bombarding energies of 1.0 and 2.5 MeV were used for beams of perpendicular incidence to the targets. Angular distributions of transmitted electrons are shown. At 1.0 MeV, total transmitted electron energy spectra are constructed from measurements in which incident electron beams were used to simulate an electron flux of intensity varying as the cosine of the angle of incidence. Targets of Al, Sn, and Au were used. Comparisons are made to calculated spectra from ETRAN 15 of Berger and Seltzer. (auth)

17260 NOMOGRAM FOR DETERMINING RANGE OF PROTONS. Nestrelyaev, V. V.; Potetyunko, G. N. At. Energ. (USSR); 29: 391(Nov 1970). (In Russian).

An empirical formula for the proton mean free path as a function of the proton energy E and atomic number Z of the absorber is $R = aZ^d e^{gZ} E^{b+cZ}$ (where a, b, c, d, and g are the parameters). The expression may be used for proton energies from 10 to 400 MeV. The mean free path was calculated with an error of the order of 10% for the elements Ne to Ta and 15%

XUM

for the other elements. The nomogram developed and its uses are described. (R.V.J.)

17261 ANGULAR AND ENERGY DISTRIBUTIONS OF FAST NEUTRON FLUX BEHIND MEDIA WITH LIMITED TRANSVERSE DIMENSIONS. Degtyarev, S. F.; Tarasov, V. V.; Tikhonov, V. K.; Tsypin, S. G. This paper was summarized in At. Energ. (USSR); 26: 453(May 1969) as paper No. 295. (In Russian).

The angular distribution of fast neutrons with energies of $E \gtrsim 1$ MeV and energy distribution of 0.8- to 8-MeV neutrons emitted from cylindrical barriers (Pb, Fe, LiH, and H_2O) 16 cm in diameter and 10, 20, and 30 cm thick were measured at various angles. Under conditions of infinite barrier and two-dimensional geometry, a significantly higher difference was observed in the angular distribution of iron and lead as compared with water and lithium hydride, which was explained by the greater loss of fast neutrons. (R.V.J.)

17262 PARTICULAR SOLUTIONS OF THE MONOENERGETIC TRANSPORT EQUATION WITH ANISOTROPIC SCATTERING. Leuthaeuser, Klaus-Dieter (Univ., Kiel). Atomkernenergie; 16: 253(1970).

In a source-free medium the neutron transport is governed by the homogeneous Boltzman equation whose general solution is given by Case's normal-mode expansion. In the presence of an inhomogeneous source term, a particular solution has to be added in order to obtain the complete solution to which the boundary conditions have to be applied. Particular solutions were obtained previously for various source terms of practical interest in the case of isotropic and linearly anisotropic scattering. These results are generalized for scattering kernels that can be approximated by finite sums of Legendre polynomials. (M.H.R.)

17263 THEORETICAL INVESTIGATION OF GAMMA-RAY TRANSPORT THROUGH MUTUALLY PERPENDICULAR SLABS. Hinkley, David E. Washington, D. C.; Catholic Univ. of America (1970). 109p. University Microfilms Order No. 70-22,145. Thesis.

The transport of gamma radiation through mutually perpendicular slabs of ordinary concrete was analyzed using Monte Carlo techniques. The in-and-down scattering is studied for various source geometrics and source energies. For actual structures the calculated parameter of interest is the attenuation factor, which is defined as the ratio of the exposure in a basement at a given detector location with a horizontal slab overhead to the exposure at the same detector location when no slab is present. The technique used to simulate a uniform fallout field was analyzed and, based upon the dose angular distribution above such a field, a source picking model developed. This model utilizes a pseudosource at the entrance face of the vertical slab and is a more-efficient procedure than that of initiating particle histories at the actual fallout source. The attenuation factors calculated using the simplified model agree to within approximately 15% of the experimental results obtained at the U. S. Army Nuclear Defense Laboratory (USANDL). The reduction factor, i.e., ratio of the dose in a structure to the free-field dose at 3 ft., for individual components agrees to within approximately 30% of the experimental results. The effect of the shape of the structure on the attenuation factor is investigated for buildings with length-to-width ratios of 1 : 1 and 4 : 1. The results agree within the stated accuracy (30%) of the Eisenhauer formulation. However, there appears to be some shape dependence, and the attenuation factor increases as the detector is moved closer to the vertical wall. (Diss. Abstr. Int., B)

17264 TOTAL CROSS SECTIONS FOR RADIATIONAL LOSSES AND RADIATIONAL ENERGY LOSSES BY FAST ELECTRONS. Stolyarova, E. L.; Samedov, V. V.; Volodin, S. N. This paper was summarized in At. Energ. (USSR); 26: 456(May 1969) as paper No. 298. (In Russian).

Schiff's calculations [Phys. Rev., 83: 252(1961)] for infinitely thin targets were taken as a basis. The fact that the total cross section for radiational losses by low-energy electrons cannot be less than the cross section in a nonrelativistic process was taken into account. The bremsstrahlung in the field of atomic electrons was also taken into consideration and Coulomb corrections were applied for electron energies above 50 MeV. The total cross sections for radiational losses in lead calculated here are shown for energies 1 to 500 MeV. They are given in the form of a ratio $\sigma_r/\bar{\sigma}$ for convenience in comparisons. (TSS)

17265 BRAGG-RULE STUDY OF ALPHA-PARTICLE STOPPING POWER IN GASEOUS COMPOUNDS. Bourland, Philip Douglas. Waco, Tex.; Baylor Univ. (1970). 143p. University Microfilms Order No. 71-2.

Thesis.

Stopping powers for alpha particles were measured in a differentially pumped gas-cell system from 300 keV to 2 MeV in fifteen gaseous compounds: H_2, N_2, O_2, NH_3, N_2O, CO, CO_2, CH_4, C_2H_2, C_2H_4, C_2H_6, C_3H_4 (methyl acetylene), C_3H_4 (allene), C_3H_6, and $(CH_2)_3$. The probable random error of the measurements varies from 1 to 3%, and the systematic error is estimated to be 1.4%. Independent measurements were also made with a sealed gas cell in a scattering chamber for N_2 and H_2; they are found to agree with the differentially pumped gas-cell measurements to within 2.7%. All measurements are compared to the independent measurements of Palmer and of Rotondi, and agreement varying from 0 to 21% is found. The additivity of atomic stopping powers, Bragg's rule, is tested for the gaseous compounds listed above except for methyl acetylene and allene whose purities are only 96 to 97%. Compounds with single and double bonds are found to obey Bragg's rule. Compounds containing triple-bond structure are found to deviate from Bragg's rule by as much as 11%, but an empirical triple-bond correction is made to fit all the data of the present experiment. Evidence is seen for a possible physical-state effect. (Diss. Abstr. Int., B)

17266 EFFECT OF CRACKS ON THE RADIATION PROTECTIVE PROPERTIES OF A CONCRETE SHIELD. Sebok, Ferenc. Epitoanyag; 21: 463-70(1969). (In Hungarian).

A new calculation method allows the safe estimation of consequences due to cracks in concrete radiation shields. The effect of cracks may be counteracted by a relatively lesser enlargement of the shield width enabling the safe and economic static design of radiation shields, including the dimensioning of cross sections based on the third-order state of stresses. (auth)

17267 NOTE ON PARTICULAR SOLUTIONS OF THE TRANSPORT EQUATION. Leuthaeuser, K. D. (Univ., Kiel). Nucl. Sci. Eng.; 43: 348-9(Mar 1971).

Nonsingular solutions of the inhomogeneous transport equation are given for isotropic and linearly anisotropic scattering. The Poincaré–Bertrand formula is applied for the proof. (M.H.R.)

17268 COMPARISON OF FEDERIGHI'S WITH MARSHAK'S BOUNDARY CONDITIONS. Canosa, Jose (IBM Scientific Center, Palo Alto, Calif.). Nucl. Sci. Eng.; 43: 349-50(Mar 1971).

Numerical results obtained with the spherical harmonics method are presented for some critical lengths of homogeneous slabs with isotropic scattering. These computations were made by means of Federighi's and Marshak's vacuum boundary conditions. The critical lengths obtained using Federighi's conditions are almost one order of magnitude more accurate than those obtained with Marshak's. Numerical results are reported, which show that, in the context of critical-length computations, Federighi's conditions give almost an order of magnitude better results than Marskak's. Further, all computer programs that use Marshak's conditions can be trivially modified to incorporate also Federighi's conditions, up to the P_{15} approximation for slabs and spheres, and up to the P_3 approximation for cylinders. (M.H.R.)

17269 ESCAPE PROBABILITY FOR CYLINDERS. Murray, Raymond L. (North Carolina State Univ., Raleigh). Nucl. Sci. Eng.; 43: 350-2(Mar 1971).

The first flight collision and escape probabilities of particles from various configurations with uniform sources have been analyzed and computed, previously. Since accurate values of these quantities are required for the study of many processes, including resonance capture, a method was developed for rapid calculation of the escape probability for circular cylinders using series techniques. The form presented can also be employed conveniently in further analytic work involving the escape probability. (M.H.R.)

Solid-State Physics

Refer also to abstracts 15908, 15910, and 17403.

Radiation Effects

Refer also to abstracts 15676, 15679, 15962, 15985, 17625, and 17651.

17270 (BNWL-tr-62) ABSORPTION CENTERS FORMING AT LOW TEMPERATURE IN CERTAIN GLASSES OF SIMPLE COMPOSITION. Orlov, N. F.; Leko, N. A. Translated for Battelle-Northwest, Richland, Wash., from Zh. Prikl. Spektrosk.; 4: 323-6(Apr 1966). 7p. Dep. NTIS.

At the temperature of liquid nitrogen, irradiation of glasses with γ rays of ^{60}Co and measurement of their induced absorption spectra was undertaken. This revealed in sodium-silicate and

nonleached sodium borosilicate glasses a considerable band growth of 640 nm; in potassium silicate glass a new band of 820 nm; and in sodium borate glass and in leached sodium-borosilicate glasses an intensity increase in the bands of 240 nm. (tr-auth)

17271 (CEA-CONF-1719) PROPERTIES OF ION-IMPLANTED Zn-Te. Marine, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 26 Oct 1970. 8p. (CONF-700945-1). Dep. NTIS (U. S. Sales Only).

From Conference on Ion Implantation, Reading, England.

P-type ZnTe crystals were implanted by chlorine ions in order to create n-type layers. Ion implantation and annealing conditions, are presented, as well as the different tests permitting one to conclude that an n-type layer was achieved in this material. Visible radiative recombination was observed when the diodes were biased in the forward direction. Details on the carrier transitions between the doping level introduced by the implantation and the valence band or the acceptor levels are presented and discussed. (auth)

17272 (CEA-R-4010) STUDY OF POINT AND CLUSTER DEFECTS IN LiF BY PHONON SCATTERING. Neumaier, Karl (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov 1970. 98p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Thermal conductivity measurements between 0.45 and 100°K were used to study point and cluster defects produced in LiF by doping or γ irradiation. In particular, measurements relative to concentration of Mg and thermal treatments, were considered. The precipitation process from solid solution was studied for a sample with a concentration of 2.3×10^{-4}. Numerical analysis and the Callaway model enabled the quantity and the number of precipitates to be determined. This quantity is remarkably well defined and depends only upon the annealing temperature. The results obtained for γ-irradiated LiF are more complex. The results are interpreted, assuming the formation of interstitial fluor in addition to the formation of F centers. A large decrease in thermal conductivity occurred with samples of pure LiF that had been heated to 800°C in a stream of water vapor; this phenomenon is attributed to resonant phonon scattering by the paraelectric OH^- center. (auth) (France)

17273 (COO-7-585) IMPLANTATION INTO FERROMAGNETIC MATERIALS. Borchers, R. R. (Wisconsin Univ., Madison). [1970]. Contract AT(11-1)-Gen-7. 53p. (CONF-700933-6). Dep. NTIS.

From Conference on Hyperfine Interactions Detected by Nuclear Radiation, Rehovot and Jerusalem, Israel.

A survey is presented on implantation into ferromagnetic materials by the Coulomb-excitation perturbed-angular-correlation (PAC) method, and the determination of hyperfine fields using this method is discussed. Conical fields, transient fields, and g-factors are considered. Examples discussed include Sm isotopes implanted into Cu and Fe by ^{16}O ions, even isotopes of Ba and Pt, etc. Finally, the use of the PAC implantation technique as a zero-energy detector of recoil ions is discussed. (D.L.C.)

17274 (SC-RR-70-753) CALCULATION OF HELIUM INDUCED STRAIN IN ErT_2 AND ScT_2. Farnum, E. H. (Sandia Labs., Albuquerque, N. Mex.). Nov 1970. 23p. Dep. NTIS.

A simple hard-sphere calculation of the volume of voids in the cubic CaF_2 lattice has been made. The calculation has been applied to ErT_2 and ScT_2 to determine the lattice-constant change caused by tritium decay and the subsequent trapping of ^3He in both the octahedral and tetrahedral voids. It is found that the calculation agrees reasonably well with experimental measurements in ErT_2 film and bulk samples and in ScT_2 bulk samples if it is assumed that all ^3He atoms migrate to octahedral voids. (auth)

17275 INVESTIGATION OF THE ANNEALING PROCESSES IN GERMANIUM IRRADIATED AT 77°K WITH 14-MeV NEUTRONS. Wolf, Dieter (Univ., Kiel). Z. Naturforsch.; 25a: 1417-27(Oct 1970). (In German).

N- and p-type germanium at 77°K was irradiated by 14-MeV neutrons and subsequently annealed. The results are compared with those obtained from reactor-irradiated materials. The observed changes of Hall constant and electrical resistivity of n- and p-type Ge can be described by the disordered-region model. In p-type Ge the disordered regions decay by isochronal annealing between 77 and 230°K. This process is superposed by the process of the creating and the decay of a type of defect that has also been observed after electron irradiation. After reactor-neutron irradiation, n-type Ge shows a reverse annealing between 100 and 150°K. In this temperature interval, no steady-state annealing effects were observed after 14 MeV- neutron irradiation. It is suggested that during each annealing stage, vacancies diffuse out of the defect zones and are trapped by small defect clusters in reactor-irradiated n-type Ge. In 14-MeV irradiated material, the vacancies diffuse until they are retrapped by the disordered regions. The process of back diffusion can be measured; it obeys an exponential law. Between 150 and 230°K after either type of irradiation, a reverse annealing takes place. It is suggested that, in this annealing interval, the defects of the disordered regions become divacancies. (auth)

17276 AMPLITUDE OF SURFACE ATOMIC VIBRATIONS IN THE (100) PLANE OF NIOBIUM. Tabor, D.; Wilson, J. (Cavendish Lab., Cambridge, Eng.). Surface Sci.; 20: 203-8(Mar 1970).

Nb(100) single crystals were bombarded with low-energy electrons and the (00) reflection intensity measured as functions of temperature and energy over the ranges 0 to 900°C and 10.8 to 500 eV. The results are discussed in terms of kinematic analysis. Mean square displacements were derived from the results and corrected for the inner potential. The results follow those for fcc metals, except that the surface vibrational amplitude is somewhat larger (2.66 compared with 2). (D.L.C.)

17277 DIFFUSE X-RAY SCATTERING IN FAST-NEUTRON-IRRADIATED COPPER CRYSTALS. Thomas, J. E.; Baldwin, T. O.; Dederichs, P. H. (Oak Ridge National Lab., Tenn.). Phys. Rev., B; 3: 1167-73(15 Feb 1971).

Nearly perfect copper crystals with dislocation densities less than $\sim 10^3/cm^2$ were irradiated with fast neutrons at doses up to $4 \times 10^{13}/cm^2$, and the diffuse x-ray scattering resulting from the defects produced was studied in a variety of situations. Measurements were made with a double-crystal spectrometer to allow observations of the scattering very close (~ seconds of arc) to the Bragg peaks, for which a theoretical analysis of the data can be made. The diffuse scattering can be explained as resulting from defect clusters or dislocation loops ~100 Å in diam; there is an asymmetry of the diffuse scattering that appears to result from a predominance of large interstitial loops. This interpretation is consistent with electron-microscopy observations on these crystals. Diffuse-scattering observations as well as anomalous x-ray transmission studies on irradiated crystals are suggested as very valuable tools to study the possibility of clustering phenomena in the annealing stages of various irradiated crystals. (auth)

17278 ANNEALING STUDY OF DILUTE ALUMINUM ALLOYS ELECTRON-IRRADIATED AT LIQUID-NITROGEN TEMPERATURE. Doyama, M. (Argonne National Lab., Ill.); Koehler, J. S.; Lwin, Y. N.; Ryan, E. A.; Shaw, D. G. Phys. Rev., B; 3: 1069-81(15 Feb 1971).

Pure and dilute aluminum alloys (Mg, Zn, Ag, Ge, Au, and In) were irradiated at about 90°K by 2- or 3-MeV electrons. Isothermal annealing for 30 min at temperature intervals 10°C apart was carried out. The major results were the following: Stage-III annealing occurs by a second-order process with an activation energy $E_{III} = 0.60 \pm 0.04$ eV for both pure and dilute aluminum alloys. Since this activation energy is the same as that found by quenching experiments, it is concluded that stage III in aluminum and dilute aluminum alloys occurs by the motion of vacancies. Two stages below stage III are dependent on the kind of impurity. A mechanism consisting of a breakup of interstitials from impurity traps (single-impurity atoms or impurity-atom clusters) can explain the experimental results. Reverse recovery of electrical resistivity was observed below and above stage III; this is due to Guinier–Preston-zone formation. (auth)

17279 ANNEALING OF ELECTRON-IRRADIATED CdS. Kitagawa, Michiharu; Yoshida, Toshio (Radiation Center of Osaka Prefecture, Osaka). Appl. Phys. Lett.; 18: 41-3(15 Jan 1971).

Isochronal annealing of radiation-induced changes in the conductivity, the carrier concentration, and the Hall mobility of CdS crystals was studied over the temperature range 90 to 410°K. High-conductivity crystals were irradiated by 10-MeV electrons near liquid-nitrogen temperature. The conductivity σ, the carrier concentration n, and the Hall mobility μ are decreased by irradiation. Three distinct annealing stages I_N, II_N, and III_N were found. The reverse-annealing process occurs slightly in stage I_N, at 100 to 130°K. Appreciable normal recovery occurs in stages II_N, 130 to 230°K and III_N, 330 to 410°K. After the annealing at 410°K, the percentages of total recovery of σ, n, and μ amount to 74, 78, and 94% of the changes, respectively. The recovery in stage II_N and stage III_N suggests that two kinds of induced acceptors, which also act as charged scattering centers, begin to migrate in the temperature ranges; one moves in stage II_N and the other in stage III_N. (auth)

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17280 MONTE CARLO CHANNELING CALCULATIONS. Barrett, John H. (Oak Ridge National Lab., Tenn.). Phys. Rev., B; 3: 1527-47(1 Mar 1971).

A Monte Carlo computer program for following the trajectories of high-energy ions in a lattice was used to study depth dependence, half-angles, and minimum yields in channeling. The program uses the Thomas–Fermi interaction between ions and lattice atoms and gives the atoms' independent thermal displacements appropriate to the temperature of the lattice. The depth dependence of the nuclear interaction probability near the surface was calculated and shown to be of importance in understanding other phenomena as well as having an intrinsic interest. Extensive calculations to explore the temperature and energy dependences of half-angles and minimum yields were done, and analytical formulas are given that summarize the computer results. The half-angle formulas give generally improved agreement with experiment and resolve certain discrepancies noted by Picraux, Davies, Eriksson, Johansson, and Mayer between their measurements and earlier theories. Minimum yields were calculated for both single- and double-alignment configurations. The results reveal an energy dependence as well as giving a better description of the temperature dependence and improved agreement with experiment. A relationship is given between the minimum yield and the yield from the surface. (auth)

17281 TYPE CONVERSION AND p-n JUNCTION FORMATION IN LITHIUM-ION-IMPLANTED ZnSe. Park, Y. S. (Aerospace Research Labs., Wright-Patterson AFB, Ohio); Chung, C. H. Appl. Phys. Lett.; 18: 99-102(1 Feb 1971).

High-conductivity n-type ZnSe implanted with Li ions gives evidence of type conversion when tested by thermal probe measurements. Photovoltaic effect, current rectification, and low-voltage electroluminescence were observed in diodes fabricated from implanted material. (auth)

17282 ION-IMPLANTATION DAMAGE IN THIN METAL FILMS. Bogardus, E. H.; Howard, J. K.; Peressini, P.; Philbrick, J. W. (East Fishkill Lab., Hopewell Junction, N. Y.). Appl. Phys. Lett.; 18: 77-80(1 Feb 1971).

Implantation of Ne^+, P^+, and As^+ (45 and 90 keV, dose = 1×10^{16} cm^{-2}) into thin films of Al, Al–Cu, and Ag produces severe damage that results in more-rapid material transport during electrical stress than in unimplanted films. Resistivity ratio measurements, i.e., resistivity at 297 and 4.2°K, appear to be sensitive indicators of this damage. (auth)

17283 CHANGES IN THE DAMPING COEFFICIENT DURING INTERRUPTED GAMMA-IRRADIATION EXPERIMENTS ON SINGLE CRYSTALS OF SODIUM CHLORIDE. Bielig, G. A.; Pollard, H. F. (Univ. of New South Wales, Kensington, Australia). J. Appl. Phys.; 42: 885-6(Feb 1971).

Resonant ultrasonic measurements were made on annealed, deformed NaCl specimens during interruption of the gamma irradiation. It was found that the normalized frequency change remained constant when the irradiation was interrupted, while the decrement kept on recovering. The damping coefficient decreases during the period of interruption. (D.L.C.)

17284 NEW S = 1 EPR CENTER IN IRRADIATED DIAMOND. Kim, Y. M. (State Univ. of New York, Albany); Watkins, G. D. J. Appl. Phys.; 42: 722-4(Feb 1971).

Electron spin resonance studies were made of natural diamond crystals electron-irradiated at room temperature. A radiation-induced spectrum is identified as arising from a new anisotropic S = 1 center. The S = 1 center is characterized by: $g_1 = 2.0026$, $g_2 = 2.0021$, $g_3 = 2.0016$; $D_1 = \mp 27$ (10^{-4} cm^{-1}), $D_2 = \mp 25$ (10^{-4} cm^{-1}), $D_3 = \pm 51$ (10^{-4} cm^{-1}). Associated with each resonance line are four sets of weaker lines which are ascribed to hyperfine interaction with ^{13}C ($I = \frac{1}{2}$, 1.1% abundant) at four nonequivalent sets of sites. The identity of the defect has not yet been established. (auth)

17285 NEW EPR SPECTRA IN IRRADIATED SILICON. Daly, D. F. (Bell Telephone Labs., Inc., Whippany, N. J.). J. Appl. Phys.; 42: 864-5(Feb 1971).

Spin-Hamiltonian parameters are reported for two new EPR spectra observed in annealed irradiated p-type (B-doped) Si. The Si–B3 spectrum is observed after fast-neutron irradiation and annealing at 270°C, and its ⟨100⟩ axial symmetry is compared with the Si–G1 spectrum. The other spectrum, Si–B4, is observed after 2.5-MeV electron irradiation and annealing at 275°C. It has ⟨111⟩ axial symmetry and is compared with the Si–G8 spectrum. The hyperfine constants of Si–B4 are also listed. Some possible explanations of the observations are offered. (D.L.C.)

17286 ELECTRON SPIN RESONANCE OF IRRADIATION-INDUCED DEFECTS IN CUBIC LEAD FLUORIDE. Rose, B. F.; Schneider, E. E. (Univ. of Newcastle upon Tyne, Eng.). Phys. Lett.; 34A: 27-8(25 Jan 1971).

Point defects on fluorine sites were induced by gamma irradiation in cubic lead fluoride at 80°K, and detected by electron spin resonance and by an associated optical absorption at 443 nm. (auth)

17287 COLOR CENTER FORMATION AND BLEACHING IN KCl AND NaCl BY ELECTRON PULSE AT 15°K. Hirai, Masamitsu; Kondo, Yasuhiro; Yoshinari, Takehisa; Ueta, Masayasu (Tohoku Univ., Sendai). J. Phys. Soc. Jap.; 30: 440-8(Feb 1971).

Primary effects of ionizing radiation in alkali halides were studied using a pulsed electron beam. In KCl, F and H centers are produced mainly by a fast process as reported previously. The half-width of the F band, however, was ~0.3 eV at ~20 nsec after the electron shot and decreased to ~0.18 eV at ~10 μsec. The fast process as well as the wide half-width of the F band suggest that the primary products are not negative ion vacancies and charged interstitials but F and H centers. In NaCl, most F centers are produced by a slow process within about 1 μsec due to the trapping of an electron at a negative ion vacancy. Absorption bands considered to originate from triplet states of self-trapped excitons are observed at 660 mμ and 610 mμ in KCl and NaCl, respectively. In connection with the decay time of these bands and with the growth time of the F band, mechanism of the F-center formation is discussed. (auth)

17288 REDUCED ELECTRONIC SCATTERING IN DECHANNELING. Campisano, S. U.; Foti, G.; Grasso, F.; Quattrocchi, R.; Rimini, E. (Univ., Catania, Italy. Istituto Nazionale di Fisica Nucleare, Catania, Italy). Phys. Lett.; 33A: 433-4(14 Dec 1970).

Direct information on the contribution of electronic multiple scattering to dechanneling is obtained by measuring the H^+ and D^+ dechanneled fraction in Si. The experimental results are compared with the theory. (auth)

17289 ION-BOMBARDMENT INDUCED RADIATION DAMAGE IN SOLIDS. Carter, G. (Univ. of Salford, Eng.); Colligon, J. S.; Grant, W. A.; Whitton, J. L. Radiat. Res. Rev.; 3: 1-68(Jan 1971).

A review is presented of ion radiation damage in solids and its differences from damage produced by other radiations. The dynamics of collisions of fast heavy particles and energy transfer leading to damage are discussed, and theories of damage production are considered. Techniques for measuring the damage, and the experimental data, are examined. Finally, surface damage (sputtering) is considered. 182 references. (D.L.C.)

17290 INFLUENCE OF γ RADIATION ON THE SURFACE STATES AND HOLE MOBILITY AT THE Si–SiO_2 INTERFACE. Kassabov, J.; Velchev, N.; Kaschieva, S. (Inst. of Physics, Sofia). Surface Sci.; 21: 366-76(Jul 1970).

The influence of γ radiation on the surface states and hole mobility at the Si/SiO_2 interface is studied by means of p-channel MOST structures. It is shown that the γ radiation causes a strong increase of the threshold voltage and decrease of the hole mobility in the channel. The experimental results were analyzed in order to determine the energy distribution and the densities of the surface states. Two discrete "fast state" levels were found after irradiation at energies 0.19 eV and 0.25 eV above the valence band edge. It was found that the reciprocal of the hole mobility depends almost linearly on the total state density. (auth)

17291 POSITRON ANNIHILATION CENTERS IN NaCl. Brandt, Werner; Waung, Hsi Fong (New York Univ., N. Y.). Phys. Rev. Lett.; 26: 496-9(1 Mar 1971).

The intensity of the long-lived component in the positron lifetime spectrum of NaCl is found to be correlated with the x-ray-induced growth and thermal annealing of the V-region color centers. If this lifetime component is attributed to positrons annihilating on defects, called annihilation or A centers, the data indicate that V-center formation reduces A-center formation. The results suggest that positron-annihilation measurement can serve as an important complement to color-center measurements in the study of defects in ionic crystals. (auth)

17292 VACANCY CLUSTERS IN FISSION-FRAGMENT-IRRADIATED TUNGSTEN. Loberg, B.; Norden, H. (Chalmers Tekniska Hoegskola, Goteborg). Ark. Fys.; 40: 421-8(1970).

Field-ion microscopy specimens of tungsten were bombarded with fission fragments. Subsequent electron and field-ion microscopy showed that the probability for formation of stable damage clusters depended on their proximity to a free surface. (auth) (Sweden)

17293 PROTON CHANNELING IN SILICON AT DIFFERENT TEMPERATURES. Kononov, B. A.; Struts, V. K. (Tomsk Poly-

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technic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 60-3(1970). (In Russian).

The channeling of 6.72-MeV protons in a silicon monocrystal at temperatures from 100 to 800°K was studied. It was found that the experimentally determined relation of the maximum channeling angle agrees with theoretical calculations. A relation was obtained between the proton channeling fraction and temperature. (tr-auth)

Physical Properties

Refer also to abstracts 16398, 16455, 16469, 16508, 16509, 16571, 15605, 17680, and 17858.

17294 (NBS-TN-560) METHODS OF MEASUREMENT FOR SEMICONDUCTOR MATERIALS, PROCESS CONTROL, AND DEVICES. Quarterly Report, April 1–June 30, 1970. Bullis, W. Murray; Baroody, A. J. Jr. (eds.) (National Bureau of Standards, Washington, D. C.). Nov 1970. 58p. GPO $0.60.

NBS activities directed toward the development of methods of measurement for semiconductor materials, process control, and devices are described. Principal emphasis is placed on measurement of resistivity, carrier lifetime, and electrical inhomogeneities in semiconductor crystals; evaluation of wire bonds, metallization adhesion, and die attachment; and measurement of thermal properties of semiconductor devices and electrical properties of microwave devices. Work on related projects on silicon nuclear radiation detectors and specification of germanium for gamma-ray detectors is also described. Supplementary data concerning staff, standards committee activities, technical services, and publications are included as appendixes. (auth)

17295 COMMENTS ON AN ELECTRON DIFFRACTION STUDY OF CESIUM ADSORPTION ON TUNGSTEN. Fehrs, D. L. (Electronics Research Center, Cambridge, Mass.); Lee, T. J.; Hopkins, B. J.; Stickney, R. E. Surface Sci.; 21: 197-202(Jun 1970).

Discrepancies are pointed out between the data of MacRae et al. (Phys. Rev. Lett., 22: 1048(1969) and Surface Sci., 15: 483(1969)) and those of Fehrs and Stickney and of Lee, Blott, and Hopkins on the work function changes and coverages for the adsorption of Cs on W(100) crystals. Two possible reasons for the discrepancies are surface contamination and different surface structure due to different processing. (D.L.C.)

17296 APPLIED SOLID-STATE PHYSICS. Low, W.; Schieber, M. (eds.). New York; Plenum Publishing Corporation (1970). 249p. $12.50.

Nine review articles are presented which are intended as a bridge between pure and applied science. Their subjects are: parametric optics, holography, light scattering with laser sources, human and electronic vision, solidification principles, crystal growth techniques, empirical approach to superconductivity, computer storage, and semiconductor photovoltaic effect and devices. A separate abstract was prepared of the superconductivity article. (D.L.C.)

For an abstract of an individual paper see: 17079.

17297 GRAPHITE CARRIER LOCATIONS AND QUANTUM TRANSPORT TO 10T (100 kG). Woollam, John A. (National Aeronautics and Space Administration, Cleveland). Phys. Rev., B; 3: 1148-59(15 Feb 1971).

The magnetoresistance, Hall effect, thermopower, thermal resistivity, and Nernst–Ettingshausen effects were measured in magnetic fields to 10.3 T (103 kG) and at temperatures between 1.1 and 4.2°K. Samples were highly ordered pressure-annealed pyrolytic graphite. The major results are that majority-carrier electrons and holes are assigned to specific locations in the Brillouin zone; the electrons are assigned to be around the center of the zone edge (point K). The first observation of spin-split Landau levels is made. A study of distorted line shapes of thermopower quantum oscillations shows agreement with a theory of Horton, Sugihara and Ono's theory, predicting field values for Landau level crossings of the Fermi energy in graphite, is confirmed for fields below 4 T. (auth)

17298 CRITICAL MAGNETIC PROPERTIES AND EXCHANGE INTERACTIONS IN EuO. Menyuk, N.; Dwight, K.; Reed, T. B. (Massachusetts Inst. of Tech., Lexington). Phys. Rev., B; 3: 1689-98(1 Mar 1971).

The critical magnetic exponents are determined for EuO and found to be $\beta = 0.368 \pm 0.005$, $\delta = 4.46 \pm 0.1$, and $\gamma = 1.29 \pm 0.01$. Within experimental error these values are consistent with the predictions of scaling theory. It is shown that the reduced magnetic field is expressible as a function only of the reduced magnetization in the critical region, with a functional dependence which differs for T above and below T_c. However, the linear model of Schofield et al. leads to a single equation of state which gives a good approximation to the data throughout the entire critical region. The results were analyzed in terms of high-temperature expansion for fcc lattices with nearest J_1 and next-nearest-neighbor J_2 interactions. It is shown that straightforward extrapolation procedures can lead to serious discrepancies. However, the analysis can be used in conjunction with susceptibility measurements both immediately above T_c and up to 370°K and with the observed γ^* behavior to determine the value of the magnetic interactions. The results indicate that J_2 is ferromagnetic and equal to $(0.5 \pm 0.2)J_1$. The disagreement between this and the previously reported value is discussed. (auth)

17299 PHOTOELECTRIC WORK FUNCTIONS OF TRANSITION, RARE-EARTH, AND NOBLE METALS. Eastman, D. E. (Thomas J. Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev., B/ 2: 1-2(1 Jul 1970).

Photoelectric work functions of polycrystalline films of Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Y, Zr, Nb, Mo, Pd, Ag, La, Ce, Nd, Sm, Eu, Gd, Hf, Pt, and Au are reported. (auth)

17300 THEORY OF MAGNETIC-MOMENT-JUMP PHASE TRANSITION WITH APPLICATION TO UP. Long, Chris; Wang, Yung-li (Florida State Univ., Tallahassee). Phys. Rev., B; 3: 1656-61(1 Mar 1971).

The simple Heisenberg-exchange Hamiltonian $H_{12} = J\vec{S}_1 \cdot \vec{S}_2$ may not represent the interaction between magnetic ions in a crystal well enough to permit a prediction of even the qualitative features of the magnetic properties. When the electric charge densities of the magnetic ions are nonspherical because of crystal field and spin–orbit interactions, the magnetic ions are coupled by electrostatic multipole interactions (EMI). When the temperature is such that there are states of different multipole moments being thermally populated, EMI can have a qualitative effect on the temperature dependence of the magnetic properties. It is shown that in the molecular-field approximation, the Hamiltonian consisting of only the crystal-field potential and the Heisenberg exchange energy cannot account for the moment-jump phase transition observed in antiferromagnetic uranium monophosphide (UP). A molecular-field theory is developed including the quadrupole–quadrupole interaction term of the EMI, and it is shown how this theory can predict the moment-jump phase transition. Finally, a calculation based on this theory is described, and the low-temperature behavior of the sublattice magnetization including the moment jump observed in UP is obtained. (auth)

17301 LATTICE DYNAMICS OF HOLMIUM. Nicklow, R. M.; Wakabayashi, N.; Vijayaraghavan, P. R. (Oak Ridge National Lab., Tenn.). Phys. Rev., B; 3: 1229-34(15 Feb 1971).

The dispersion relation for the normal modes of vibration of holmium metal at room temperature was measured by means of slow-neutron inelastic scattering techniques. Phonon frequencies for wave vectors along the principal symmetry directions were determined and, in addition, some experimental information about the phonon frequencies along the boundaries of the Brillouin zone is reported. The data were fitted with a Born–von Kármán force model, which includes interactions out to the eighth-nearest neighbor. The interactions were assumed to be general (tensor) out to the fourth-nearest neighbor and axially symmetric beyond. The model was used to calculate a frequency distribution function $g(\nu)$, the lattice specific heat, and the corresponding Debye temperature. (auth)

17302 ISOTOPE EFFECT FOR CATION SELF-DIFFUSION IN SINGLE CRYSTALS OF NiO. Volpe, M. L.; Peterson, N. L.; Reddy, J. (Argonne National Lab., Ill.). Phys. Rev., B; 3: 1417-21(15 Feb 1971).

The isotope effect for cation self-diffusion was determined by simultaneous diffusion of ^{57}Ni and ^{66}Ni tracers in NiO crystals. The strength of the isotope effect $f\Delta K$ is 0.613 ± 0.021, independent of temperature in the range from 1201 to 1678°C. This result is consistent with cation self-diffusion by a vacancy mechanism only, and $\Delta K = 0.784 \pm 0.027$. (auth)

17303 MAGNETIC ANISOTROPY OF V_2O_3 SINGLE CRYSTALS. Greenwood, Morris; Mires, Raymond W.; Smith, Alfred R. (Texas Tech. Univ., Lubbock). J. Chem. Phys.; 54: 1417-18(1 Feb 1971).

The magnetic anisotropy of V_2O_3 single crystals was measured at 4 to 700°K, which covers the high-temperature Mott (metal–insulator) transition at 400 to 500°K. Curie–Weiss fits were made on the curve; the results show that the Curie–Weiss law fits the data much better above 550°K than below 400°K. This is interpreted as evidence for a localized-moment insulating phase. (D.L.C.)

17304 KONDO SIDEBANDS IN $CeAl_3$ AND RELATED PSEUDOBINARY COMPOUNDS. Buschow, K. H. J.; van Daal, H. J.;

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Maranzana, F. E.; van Aken, P. B. (Philips Research Labs., Eindhoven, Netherlands). Phys. Rev., B; 3: 1662-70(1 Mar 1971).

The temperature dependence of the electrical resistivity (1.3 to 300°K) was studied for the isomorphous compounds $Ce_{1-x}La_xAl_3$, $Ce_{1-x}Y_xAl_3$, and $Ce_{1-x}Th_xAl_3$. In these compounds, one or two maxima have been observed in the ρ-vs-T curve. An analysis of the experimental results is presented in terms of the Kondo side-band theory, which describes Kondo exchange scattering of the conduction electrons in the presence of localized moments whose ground-state manifold is split owing to the presence of crystalline fields. It is shown that the changes observed in ρ behavior for $CeAl_3$ upon replacement of Ce by La, Y, or Th can be correlated with changes in the crystal field parameters, and in the case of Th also with changes in the density of states of the conduction electrons. (auth)

17305 PREDICTING THE GALVANOMAGNETIC COEFFICIENTS OF TUNGSTEN FROM FERMI-SURFACE DATA. Long, Jerome R. (Virginia Polytechnic Inst., Blacksburg). Phys. Rev., B; 3: 1209-14(15 Feb 1971).

In the context of specific scattering processes, the galvanomagnetic coefficients of a metal crystal should be expressible in terms of features of the Fermi surface. For energy surfaces more complex than ellipsoids, however, analytical solutions of the transport equations with even the most tractable scattering assumptions have not been found, except in quadratures or in an asymptotic limit of the applied magnetic field. A procedure is introduced for the purpose of predicting approximate values of arbitrary-field galvanomagnetic coefficients of a metal with nonellipsoidal Fermi-surface sheets. The procedure is based upon a semi-empirical extension of the solution for ellipsoids. An application of the procedure to the Fermi surface of tungsten and measurements of the low-field galvanomagnetic coefficients of a tungsten crystal are described. The prediction is generally successful. No attempt is made to adjust parameters or obtain best fits to curves. The intent is to show how closely one can estimate by a simple, first-trial method. (auth)

17306 EVIDENCE FOR A FIRST-ORDER STRUCTURAL TRANSFORMATION IN Nb_3Sn. Vieland, L. J. (RCA Labs., Princeton, N. J.); Cohen, Roger W.; Rehwald, Walther. Phys. Rev. Lett.; 26: 373-6(15 Feb 1971).

Experimental evidence is presented that the structural transformation observed in Nb_3Sn is first order, as predicted by theories that invoke a band Jahn–Teller mechanism for the lattice instability. The magnitude of the spontaneous lattice distortion at the transition temperature is in excellent agreement with the theory. (auth)

17307 EQUATION OF STATE FROM A PHENOMENOLOGICAL MODEL FOR THE KONDO SYSTEM La:Ce. Edelstein, A. S. (Univ. of Illinois, Chicago); Windmiller, L. R.; Ketterson, J. B.; Crabtree, G. W.; Bowen, S. P. Phys. Rev. Lett.; 26: 516-19(1 Mar 1971).

Data on the temperature and field dependence of the susceptibility of La–Ce alloys are presented for temperatures $T \geq 0.6$°K and fields up to 50 kG. The data show that the susceptibility $\chi = cF(T, H)$, where F is nearly independent of the concentration c. A phenomenological model predicts a susceptibility which agrees with the experimental F(T, H). (auth)

17308 EFFECT OF DEFORMATION TEMPERATURE ON THE STAGE III RECOVERY IN NIOBIUM. Amano, Muneyuki; Sasaki, Yasuo (National Research Inst. for Metals, Tokyo). J. Jap. Inst. Metals; 34: 1232-7(Dec 1970). (In Japanese).

The thermal recovery of the increase in electrical resistivity caused by the deformation of niobium was studied. Polycrystalline niobium wires were strained in tension at temperatures from −196 to 50°C with strain rates of 3.3×10^{-5} to 3.3×10^{-3} sec^{-1}. The increase in electrical resistivity with strain was nearly linear and was strongly dependent upon the deformation temperature. The isochronal recovery curves of specimens revealed the well defined stage III recovery centered around 160°C and the strain aging was found at this recovery stage by the tensile test. The total recovery in this stage increased with decreasing deformation temperature and increasing strain. The effect of strain rate on this recovery was not observed apparently. The resistivities of the specimens which were stretched by 5% at each temperature and subsequently annealed up to 220°C showed a negative deviation from the initial resistivity. It is concluded that the recovery in the stage III is mainly caused by the clustering of oxygen atoms to dislocations and the dependence of the stage III recovery on deformation temperature is attributed to the difference in the dislocation density. The experimental results suggest that the change in dislocation density with strain increases with decreasing temperature. (auth)

17309 EFFECT OF IRON AND MOLYBDENUM ADDITIONS ON THE PROPERTIES OF NEW HIGH MAGNETIC PERMEABILITY ALLOYS NIMALLOY IN NICKEL AND MANGANESE SYSTEM. Masumoto, Hakaru; Murakami, Yuetsu; Hinai, Masakatsu (Research Inst. of Electric and Magnetic Alloys, Sendai). J. Jap. Inst. Metals; 34: 1242-7(Dec 1970). (In Japanese).

Much work has been carried out to investigate the effects of various element additions on the properties of Ni–Mn alloys, and numerous alloys having superior magnetic properties have been obtained. It has been known that the cooling rate should be as large as possible for the Ni–Mn–Fe alloys and as small as possible for the Ni–Mn–Mo alloys in order to develop their excellent magnetic properties. Therefore the Ni–Mn–Fe–Mo system was investigated to obtain alloys that exhibit the superior magnetic properties of the Ni–Mn–Fe–Cr system at a moderate cooling speed such as furnace cooling. The highest initial permeability of 46540 was obtained for the alloy composed of 76.88% Ni, 11.22% Mn, 4.67% Fe, and 7.23% Mo when cooled at a rate of 400°C/hr from 900°C, and the highest maximum permeability of 270,000 was obtained for the alloy of 77.13% Ni, 10.66% Mn, 5.15% Fe, and 7.06% Mo when cooled at a rate of 2800°C/hr from 900°C. The latter alloy showed a coercive force of 0.0019 Oe and a magnetic hysteresis loss of 0.53 erg/cm^3/cycle for the maximum magnetic induction of 1000 G, its electrical resistivity being 89.4 $\mu\Omega$-cm at 20°C. (auth)

17310 THEORY OF DYNAMIC NUCLEAR POLARIZATION. Buishvili, L. L.; Giorgadze, N. P. Sov. Phys.-Solid State (Engl. Transl.); 12: 1439-40(Dec 1970).

Translated from Fiz. Tverd. Tela; 12: 1817-19(Jun 1970).

The probabilities of flip-flop and flip-flip transitions in solids are not generally equal. This fact is shown to mean that saturation of the electron resonance may lead to an appreciable increase in the nuclear polarization. (D.L.C.)

17311 FIELD DEPENDENCE OF THE MAGNETIZATION AND SPIN-WAVE CORRELATIONS IN FERROMAGNETIC $CrBr_3$. Cobb, C. H. (Univ. of California, Santa Barbara); Jaccarino V.; Remeika, J. P.; Silberglitt, Richard; Yasuoka, H. Phys. Rev., B; 3: 1677-88(1 Mar 1971).

Using the ^{53}Cr NMR, the field dependence of the magnetization $M(T_0,H)$ at elevated temperatures of single-crystal ferromagnetic $CrBr_3$ was determined. While an accurate fit to the $M(T_0,H)$-vs-H data can be obtained using a two-exchange-parameter first-order renormalized spin-wave theory, the parameters required differ appreciably from those required for an accurate fit to the previously obtained M(T,0)-vs-T data with the same theory. A t-matrix two-parameter–model theory, correct to lowest order in the magnon density, but to all orders in the magnon–magnon interaction, was constructed. Although both the first-order and t-matrix corrections to the spin-wave energies are sizable, the full t-matrix results only change the large first-order corrections to M(T,H) by 15%. However, even if one employs the full t-matrix renormalization there are no pairs of values of the two exchange parameters which simultaneously fit the M(T,0)-vs-T and $M(T_0,H)$-vs-H data. The inability of the more sophisticated theory to provide agreement with measurements of more than one thermodynamic function is attributed to be an inadequacy of the two-parameter model rather than an intrinsic failure of the theoretical approach. (auth)

17312 INFRARED PROPERTIES OF YTTRIUM OXIDE. Nigara, Yutaka; Ishigame, Mareo; Sakurai, Takemaro (Tohoku Univ., Sendai). J. Phys. Soc. Jap.; 30: 453-8(Feb 1971).

By using a large solar furnace, yttrium oxide crystals were made by a fusion process, and their reflectivity was measured in the spectral region 700 to 10 cm^{-1}. Several reststrahlen bands extending from 600 to 240 cm^{-1} were found. From the reflectivity curve, the parameters of seven lattice vibrations were analyzed, and the optical constants in a wide spectral region were deduced. The transmittance measurement was made by using crystalline powder embedded in a polyethylene film and several weak bands were found in the far-infrared region. By measuring the transmittance of a thin plate of fused crystal, a number of summation bands were observed in the near-infrared region. In summarizing the bands, some considerations were given on the vibrational behavior of yttrium oxide crystals. (auth)

17313 CONTACT POTENTIAL DIFFERENCE MEASUREMENTS ON (010) SURFACES OF VANADIUM PENTOXIDE. Hevesi, I.; Sueli, A.; Gyulai, J. (Jozsef Attila Univ., Szeged). Acta Phys. Acad. Sci. Hung.; 29: 79-83(1970).

Changes in contact potential difference (C. P. D.) between freshly cleaved (010) vanadium pentoxide surfaces and a platinum electrode were investigated, using different ambients. Experiments show the logarithmic time dependence of C. P. D. during stabilization and also the important role of the presence of humidity. (auth)

17314 DIFFUSE SCATTERING OF ELECTRONS BY DEFECTS IN CRYSTALS. II. STRUCTURE ANALYSIS OF THE

GUINIER–PRESTON ZONE IN Cu–Be ALLOY. Hasebe, Katsuhiko; Okabe, Toshio; Mannami, Michi-hiko (Kyoto Univ.). J. Phys. Soc. Jap.; 30: 417-21(Feb 1971).

The intensity distribution along the diffuse streaks in the electron-diffraction patterns from the Guinier–Preston zones in Cu–Be alloy is analyzed, and a model of the structure of the zone is proposed. (auth)

17315 TEMPERATURE DEPENDENCE OF THE POSITRON-ANNIHILATION ANGULAR CORRELATION IN METALS. Bergersen, Birger (McMaster Univ., Hamilton, Ont.); Pajanne, Erkki. Phys. Rev., B; 3: 1588-98(1 Mar 1971).

The thermal smearing of the positron-annihilation–angular-correlation curves is studied. In the case where the medium is a homogeneous interacting electron gas in thermal equilibrium, the analysis applied by Stewart and co-workers to the thermal smearing is shown to correctly give the effective mass. In conjuction with previous calculations of the effective mass, our results indicate that the observed thermal smearing cannot be explained as mainly caused by electron-gas effects. It is shown how the model can be modified to take into account the positron–phonon interaction. This reduces the discrepancy between theory and experiment, but not sufficiently to account fully for the experimental data. It is argued that new experiments are needed before one can decide whether it is necessary to consider new mechanisms in order to explain the effect. A convenient formalism is presented that allows one to calculate all positron quantities at moderate nonzero temperatures within a given approximation scheme. The "ladder" approximation is used to illustrate the argument and to estimate correction terms. (auth)

17316 PRESSURE EFFECT OF THE HALL COEFFICIENT OF INDIUM AND INDIUM-RICH ALLOYS. Sasaki, Masaru; Matsuda, Takeshi; Yonemitsu, Kiyoshi; Sato, Takao (Tokyo Metropolitan Univ.). J. Phys. Soc. Jap.; 30: 412-16(Feb 1971).

The variations of the Hall coefficient R_H of indium and indium-rich alloys (In–Tl and In–Pb) were measured in the range of 1 to 8000 atm at room temperature. The R_H of pure In increases with the rate of 3.4×10^{-13} (m^3/C)/katm, and changes its sign at about 8000 atm. For the sake of comparison, the variation of R_H of Al and Pb was also measured. The observed results are discussed in terms of two conceivable origins: one is the anisotropic electron–phonon scattering, and the other is the effect of the lattice potential. (auth)

17317 HALL EFFECT IN ORIENTED α-Pu. Loree, T. R.; Pinnick, H. T. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater.; 38: 143-9(Feb 1971).

The ordinary Hall effect was measured for random α-Pu and two configurations of oriented α-Pu. The results were interpreted in terms of a hexagonal model with two components determining the Hall coefficient. The behavior of these components was qualitatively explicable by considering a Jones zone construction. Some evidence for antiferromagnetic ordering is seen at low temperatures. (auth)

17318 COMPTON PROFILE ANISOTROPY IN GRAPHITE. Felsteiner, J.; Fox, R.; Kahane, S. (Israel Inst. of Tech., Haifa). Phys. Lett.; 33A: 442-3(14 Dec 1970).

The Compton profile in graphite was measured using 59.54-keV ^{241}Am gamma rays. A significant anisotropy was found, in agreement with reported positron-annihilation results but in contrast with recent Compton profile measurements using Mo Kα x rays. (auth)

17319 NEW COMPOUND IN THE ZIRCONIUM–OSMIUM ALLOY SYSTEM. McCarthy, S. L.; Schmidt, L. (Univ. of California, San Diego, La Jolla). J. Less-Common Metals; 23: 241-3(Feb 1971).

A compound in the Zr–Os system, with an fcc unit cell (a_0 = 13.428 ± 0.004 Å), was found to have a composition of 26.7 ± 0.3 at. % Os. The stoichiometric composition $Zr_{11}Os_4$ is proposed. This is the first compound in the Zr-rich part of the phase diagram that has been reported. The existence of superconductivity was used as a tool to check the stoichiometry of the new compound. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 15933 and 15934.

17320 PRESSURE DEPENDENCE OF THE KNIGHT SHIFT IN Al AND Nb METAL. Kushida, Toshimoto; Murphy, J. C. (Ford Motor Co., Dearborn, Mich.). Phys. Rev., B; 3: 1574-88(1 Mar 1971).

The pressure dependence of the Knight shift K of Al and Nb metals was measured with a digitally slaved signal averager. The maximum hydrostatic pressure utilized was 8000 kg/cm^2. The observed value of d ln K/d ln V is -1.01 ± 0.02 and -0.29 ± 0.02 for Al and Nb, respectively. Since it is essential to know the volume dependence of the (electron–electron-enhanced) spin susceptibility d ln χ^*_{sp}/d ln V in order to analyze the observed d ln K/d ln V, the theoretical implication of the previously proposed methods to estimate d ln χ^*_{sp}/d ln V was explored. The linearly temperature-dependent thermal expansion at low temperature α_e gives rise to the volume dependence of electron–phonon-enhanced density of states at the Fermi surface. α_e includes only a temperature-independent part of the enhancement factor $1 + \lambda$. The pressure dependence of the superconductor parameters renders the volume dependence of the density of states clothed with a full electron–phonon interaction, which includes the temperature-independent part as well as a possible temperature-dependent part. A semi-empirical scheme to deduce the volume dependence of $1 + \lambda$, the density of states for the bare electrons $N(E_F)_{BS}$, and the band-structure effective mass m* is proposed. These values are derived from the pressure dependence of the superconducting transition temperature and α_e. The volume dependence of χ^*_{sp} is deduced from d ln $N(E_F)_{BS}$/d ln V by taking into account the electron–electron enhancement factor. The volume dependence of the density of wave function at the Fermi surface $\langle|\psi(0)|^2\rangle$ was deduced for Al as d ln $\langle|\psi(0)|^2\rangle$/d ln V = −2.12. The volume dependence of the orbital Knight shift K_0 for Nb is estimated as d ln K_0/d ln V ≃ 0.4 (or 0.1). The possible origin of the discrepancy between the density of states derived from α_e and from the pressure dependence of the superconductor parameters is discussed. The origin of inconsistency in the previously reported temperature dependence of K for Al is also suggested. (auth)

17321 EFFECT OF CRYSTALLINE FIELD ON THE KNIGHT SHIFT IN $SmSn_3$ AND $SmAl_2$. Malik, S. K.; Vijayaraghavan, R. Tata Inst. of Fundamental Research, Bombay). Phys. Lett.; 34A: 67-8(25 Jan 1971).

It is shown that the White–Van Vleck crossover point of the ^{119}Sn Knight shift in $SmSn_3$ and ^{27}Al Knight shift in $SmAl_2$ is suppressed due to the mixing of the excited J states into the ground J state of Sm^{3+} ion by strong crystalline fields. Two crossover points may also occur in some samarium compounds. (auth)

17322 SOME PROBLEMS OF THE KINEMATIC THEORY OF BRAGG SCATTERING OF RESONANT γ RAYS. Pham Zuy Hien. Zh. Eksp. Teor. Fiz.; 59: 2083-90(Dec 1970). (In Russian)

The kinematic theory of resonant γ-ray diffraction in single crystals is studied. Bragg scattering differential cross sections are calculated for the cases of complete degeneracy and Zeeman splitting of nuclear levels (in collinear type ferro- and antiferromagnets); the contributions from nuclear resonance, Rayleigh, and interference scattering are determined exactly. The Moessbauer diffraction spectrum is also calculated by taking into account absorption of the primary and secondary beams in the scatterer. (auth)

17323 MOESSBAUER SPECTRA AND MAGNETIC SUSCEPTIBILITY OF NEPTUNIUM TETRACHLORIDE BELOW 85°K. Stone, J. A.; Jones, E. R. Jr. (E. I. du Pont de Nemours and Co., Aiken, S. C.). J. Chem. Phys.; 54: 1713-18(15 Feb 1971).

Magnetic properties of $NpCl_4$ were studied from 2.6 to 85°K, with the Moessbauer resonance of the 59.54-keV γ ray in ^{237}Np, and with magnetic susceptibility measurements from 4.3°K using a vibrating-sample magnetometer at applied fields of 50 to 10,000 Oe. A ferromagnetic transition was found at 6.7 ± 0.1°K. Above the Curie temperature, $NpCl_4$ obeys the Curie–Weiss law $\chi = C/(T - \theta)$ with θ equal to 6.9°K, giving an effective moment of 3.08 μ_B. The Moessbauer data define the temperature dependence of the hyperfine fields in $NpCl_4$. The behavior of the magnetic hyperfine field at the Np nucleus parallels that of the magnetization in the ferromagnetic region, giving an extrapolated H(0) of 3000 kOe. In the paramagnetic region only a small temperature-independent quadrupole splitting was observed. (auth)

Theory

17324 RARE-EARTH SPIN-DISORDER RESISTIVITY AND SPIN–ORBIT COUPLING. Legvold, S. (Iowa State Univ., Ames). Phys. Rev., B; 3: 1640-2(1 Mar 1971).

Without corrections for Fermi-surface effects, the total-spin-disorder electrical resistivity of heavy-rare-earth single crystals is accidentally proportional to $S(S + 1)$ in the basal plane and to $(\lambda - 1)^2 J(J + 1)$ in the c direction. When Fermi-surface effects are included, results show $(\lambda - 1)^2 J(J + 1)$ dependence in both directions. (auth)

XUM

17325 PHONON DRAG IN GRAPHITE. Jay-Gerin, J. P.; Maynard, R. (Centre de Recherches sur les Tres Basses Temperatures, Grenoble, France). J. Low Temp. Phys.; 3: 377-92(Oct 1970).

This paper is principally concerned with the electron–phonon interaction near the Kohn condition ($q = 2k_F$) in crystals such as graphite, where the anisotropy of both the Fermi surface and the vibration spectrum is extremely large. By neglecting the trigonal warping of the Fermi surface of graphite, the inverse phonon lifetime is evaluated and is found to have a sharp maximum for the phonons in the Kohn regime. With increasing temperature, the thermal smearing of the Fermi surface leads to a lowering of the magnitude of this peak, which decreases approximately as T^{-1}. The previous conclusions seem to remain valid when the trigonal warping is taken into account. By arguing that the effectively dragged phonons are just the phonons within the Kohn regime, it is found that the phonon-drag component of the thermoelectric power reflects this strong coupling. In spite of numerous approximations in the calculations, a one-parameter fit to the experimental results seems to give satisfactory agreement. The model furthermore predicts the right negative sign of the thermoelectric anomaly, provided the new carrier assignment of Schroeder et al. is used. (auth)

Theoretical Physics

Refer also to abstracts 16832, 16843, 17018, 17428, 17985, and 18174.

17326 (IS–2300, pp 90-100) MATHEMATICS AND COMPUTER DIVISION. Carlson, B. C.; Lambert, R. J.; Maple, C. G.; Stewart, R. M. (Ames Lab., Iowa).

From Ceramic Engineering, Chemical Engineering, Chemistry, Mathematics and Computer Science, Metallurgy, Physics, and Reactor Divisions annual summary research report, July 1969–June 1970.

Research on computers, mathematics and programing is summarized. These summaries cover real-time control systems and special functions of mathematical physics, including hidden symmetries of special functions, inequalities for a symmetric elliptic integral, and algorithms involving arithmetic and geometric means. Other topics covered are mixed arithmetic and geometric means, automatic debugging of programs, precision calculation of eigenvalues and eigenvectors of matrices, automatic numerical analysis, and a new feedback mechanics for SDI. Also discussed are systems simulation, real-time multi-tasking direct digital control system, real-time operating systems, language design and translation, and formal languages. (J.F.P.)

17327 PROJECTING OPERATORS IN THE THEORY OF IRREVERSIBLE PROCESSES. Yulmet'ev, R. M. Ukr. Fiz. Zh.; 15: 881-7(Jun 1970). (In Russian).

The basic problems of irreversible processes are considered, i.e., the calculation of TCF (time correlation functions) and the distribution function dependence on time. The method of deriving these quantities is suggested on the basis of Zwanzig–Nakajima projection operators. An infinite hierarchy of kinetic equations determining the dynamics of initial functions is found by the successive projections in the space of the conditional two-time distribution functions. The equations are characterized by non-Markov structure and connect the variation of the functions with kernels of increasing order. The parameters determining the kinetics of the functions are calculated by means of equilibrium distribution functions, which are considered to be known. The calculation of TCF for the quantum systems is discussed separately in Wigner's representation. As an example, from the general formulas of the theory, the approximate kinetic equation for a one-particle distribution function is obtained in the form of the microscopic Fokker–Planck equation. (auth)

17328 HYDROGEN ATOM IN SUPERSTRONG MAGNETIC FIELDS: RELATIVISTIC TREATMENT. Barbieri, R. (Scuola Normale Superiore, Pisa, Italy). Nucl. Phys.; A161: 1-11(1971).

The hydrogen atom is studied in superstrong magnetic fields characteristic of neutron-star models for pulsars. In particular, the Dirac Hamiltonian for an electron in an external four-vector potential $A_\mu = (\frac{1}{2}\mathcal{H} \times r, -e^2/r)$ is diagonalized in the adiabatic approximation. A very deep ground state for the atom is found, which is related to a strong contraction of the electron orbit in the plane perpendicular to the magnetic field direction. The physical consequences of these results are also discussed. (auth)

17329 EXACT SOLUTION OF A ONE-DIMENSIONAL ELECTRICAL TRANSPORT PROBLEM WITH ELASTIC AND INELASTIC SCATTERING. Gerwin, R. (Boeing Scientific Research Lab., Seattle). Physica; 49: 565-90(16 Nov 1970).

A gas of charged particles making elastic and inelastic collisions is assumed to be in a uniform steady state in a uniform steady electric field. Supposing the gas obeys a one-dimensional Boltzmann equation, this is solved exactly for the case of energy-independent elastic and inelastic mean free paths, together with the assumption of isotropic scattering. (Of course, the inelastic mean free path is taken to be infinite for those particles with too little energy to be inelastically scattered.) The drift velocity and temperature are obtained from the velocity distribution, and their dependences on electric field strength are displayed. The results exhibit many features in common with other theories and with experiments on n-type germanium at liquid-nitrogen temperature. (auth)

17330 COMPLETENESS OF THE SET OF SOLUTIONS FOR RADIAL SCHROEDINGER EQUATION WITH NUCLEAR–COULOMB POTENTIAL IN A λ PLANE. Poplavskii, I. V. (Odessa Construction-Engineering Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 111-15(1970). (In Russian)

Correlations of completeness were derived for the set of solutions of radial Schroedinger equations with nuclear–Coulomb potential in a complex λ plane at a fixed physical value of energy. (tr-auth)

17331 INVERSE PROBLEM IN COMPLEX λ PLANE IN PRESENCE OF COULOMB INTERACTION. Poplavskii, I. V. (Odessa Construction-Engineering Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 116-20(1970). (In Russian).

An inverse problem of the theory of scattering in a complex λ plane was resolved for the case with nuclear–Coulomb potential. A generalized Yukawa potential was taken as a nuclear potential. It is shown that, using a spectral function assigned in a λ plane, it is possible to reduce single-valued nuclear potentials. The problem was reduced to the solution of the Gel'fand–Levitan type integral equation with its kernel expressed by Yoss solutions for the radial Schroedinger equation with a Coulomb potential and a spectral function. (tr-auth)

17332 EFFECTIVE ELECTRON–ION INTERACTION BY THE CANONICAL-TRANSFORMATION METHOD. de Freitas, L. G.; Lobo, R. (School of Engineering, Sao Carlos, Brazil). Nuovo Cim.; 1B: 34-40(11 Jan 1971).

The effective electron–ion interaction is obtained by use of a canonical transformation followed by standard linearization of the equations. The results justify the works of Kleinman and Langreth. (auth)

17333 DEFENSE OF A MEASUREMENT THEORY. Krips, H. (Univ. of Adelaide). Nuovo Cim.; 1B: 23-33(11 Jan 1971).

The theory of measurements is defended against criticisms by an examination of the role of the density operator in quantum mechanics. The Schroedinger cat paradox, and the Einstein, Podolski, Rosen paradox are discussed. (auth)

17334 PERTURBATION THEORY IN TERMS OF REDUCED DENSITY MATRICES. Harriman, John E. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 54: 902-8(1 Feb 1971).

A simple perturbation theory was developed for reduced density matrices known to be N-representable as functions of some set of independent parameters. Formulas are presented for single and double perturbations through second order. Extension to higher order would be possible, but involved. The results do not depend explicitly on the order of the density matrix, and when the N-particle density matrix is used, the formulas can be reduced to those of conventional Rayleigh–Schroedinger theory. Details are given for the special cases of spin-unrestricted or extended SCF density matrices and CI or optimized multiconfiguration density matrices which are known to be N representable. (auth)

17335 POINT DYNAMIC MODEL FOR THE CAUSAL INTERPRETATION OF WAVE MECHANICS. Matrai, T. (Teacher's Training Coll., Eger, Hungary). Acta Phys. Acad. Sci. Hung.; 28: 323-35(1970).

A universal method is found to express the real amplitude A of the complex wave function $\psi = Ae^{iS/\hbar}$ as the real function of S (action) from the continuity equation of wave mechanics. In this way, quantum potential may be given as a function of S. Thus the wave-mechanical eikonal equation contains the function S only. Considering the resulting equation as the wave-mechanical generalization of the Jacobian point dynamical equation, the wave-mechanical generalization of the Newtonian equation of motion might be given. Moreover, as a consequence, it is pointed out that the $\psi\psi^* = A^2$ really means density of particles or the probability of their finding even in this interpretation. (auth)

17336 MEASUREMENT THEORY IN QUANTUM MECHANICS ACCORDING TO DANERI-LOINGER-PROSPERI. CRITICAL

STUDY. Jasselette, P. (Univ., Liege. Univ. Officielle du Congo, Lumumbashi); Voisin, J. Riv. Nuovo Cim.; 2: 278-95 (Apr-Jun 1970). (In French).

The discussion of measurement theory covers direct and indirect knowledge, two poles of a physical theory, Euclid geometry, direct and indirect measurement, measurement in quantum mechanics, and the Dáneri, Loinger, and Prosperi theorem. (J.F.P.)

17337 LONG-DISTANCE CORRELATIONS OF CHARGED PARTICLES. Wadati, M.; Isihara, A. (State Univ. of New York, Buffalo). Phys. Rev., B; 1: 2156-63(1 Mar 1970).

The spatial correlation functions of charged particles are evaluated explicitly in the chain-diagram approximation. The results are important at large distances. Three different cases are considered: (1) classical electrons, (2) metallic electrons, and (3) charged bosons. Quantum corrections to the correlation function of classical electrons are expressed in terms of a convenient parameter $\alpha = \lambda\kappa_0$, where λ is the de Broglie thermal wavelength and κ_0 is the Debye constant. The correlation function of metallic electrons deviates from that of classical electrons markedly for higher densities. It is evaluated for several different densities. The correlation functions of charged bosons for various densities can be reduced in a universal form. The fermion and boson cases are evaluated for 0°K. The resulting curves show small oscillations at relatively large distances. (auth)

17338 STATISTICAL MECHANICS OF INTERACTING SYSTEMS. Trivedi, P. C. (Brock Univ., St. Catharines, Ont.). Progr. Theor. Phys. (Kyoto); 44: 1192-1207(Nov 1970).

A mathematical technique is introduced to sum the iteration series that occurs in the electron gas theory of Montroll and Ward (Phys. Fluids, 1: 55(1958)). As a result, summation over ring diagrams becomes easier to perform than is the case for Montroll and Ward. The binary kernel of Lee and Yang is expressed as a sum of kernels that are solutions of integral equations obtained by iteration. This formalism provides a method to calculate the binary kernel. The grand partition function is calculated by solving the integral equation and is applied to the calculation of the Debye–Hückel equation of state. (auth)

17339 STATISTICAL MECHANICS OF QUANTUM MECHANICAL PARTICLES WITH HARD CORES. II. THE EQUILIBRIUM STATES. Miracle-Sole, Salvador (CNRS, Marseille); Robinson, Derek W. Commun. Math. Phys.; 19: 204-18(1970).

The states of a quantum-mechanical system of hard-core particles are characterized as a convex weak* compact subset of the states over a C* algebra associated with the canonical (anti-) commutation relations. It is shown that the mean conditional entropy, i.e., entropy minus energy, can be defined as an affine upper semicontinuous function over the G-invariant hard core states where G is an invariance group containing space translations. An abstract definition of the pressure and equilibrium states is given in terms of the maximum of the conditional entropy, and it is shown that the pressure P_s obtained in this way satisfies $P \geq P_S \geq P_\infty$ where P and P_∞ are the thermodynamic pressures obtained from the usual Gibbs formalism with elastic-wall and repulsive-wall boundary conditions, respectively. A number of additional results concerning the equilibrium states are also given. (auth)

17340 CORRELATIONS BETWEEN EIGENVALUES OF A RANDOM MATRIX. Dyson, Freeman J. (Inst. for Advanced Study, Princeton, N. J.). Commun. Math. Phys.; 19: 235-50 (1970).

Exact analytical expressions are found for the joint probability distribution functions of n eigenvalues belonging to a random Hermitian matrix of order N, where n is any integer and $N \to \infty$. The distribution functions, like those obtained earlier for n = 2, involve only trigonometrical functions of the eigenvalue differences. (auth)

17341 UNSTABLE-PARTICLE GASES: NEGATIVE-LIFETIME CASE. Delano, Michael D. (Yeshiva Univ., New York). Phys. Rev., A; 3: 725-8(Feb 1971).

The total excluded volume for a gas of stable particles with repulsive interactions is calculated. From this, it is possible to define an effective negative-interaction number density which is formally identical to the previously derived expression for the equilibrium number density of unstable particles. Pointing out that this allows the unstable-particle formalism to be extended to the negative-lifetime case, it is argued that unstable particles with negative lifetimes behave effectively like a gas of unstable holes. (auth)

17342 KINETIC AND MAGNETIC MOMENTS I THE DIRAC–HESTENES THEORY. Casanova, Gaston. Compt. Rend., Ser. A; 271: 817-20(19 Oct 1970). (In French).

Planar solutions ($\beta = 0$) in the nonrelativistic approximation of the Dirac–Hestenes theory lead to space quantization and the establishment of the Stoner rule. The study of the action of a sufficiently weak magnetic field shows that the intrinsic magnetism does not affect the energy variations. Thus the Lande formula can be established. (auth) (France)

17343 SELF-CONSISTENT HARTREE–FOCK CALCULATION OF THE DIELECTRIC FUNCTION OF AN ELECTRON GAS. Woo, James W. F.; Jha, Sudhanshu S. (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev., B; 3: 87-91 (1 Jan 1971).

The dielectric function of the electron gas was calculated in the self-consistent Hartree–Fock approximation. Results are presented and compared with that obtained in random-phase approximation and Hubbard theories. (auth)

17344 RELATIVISTIC KINETIC THEORY OF PARTICLES WITH A MAGNETIC DIPOLE MOMENT IN AN EXTERNAL ELECTROMAGNETIC FIELD. IV. TRANSPORT COEFFICIENTS AND SPACE–TIME INVARIANCE PRINCIPLES. van Weert, C. G. Kon. Ned. Akad. Wetensch., Proc., Ser. B; 73: 517-34(1970).

Expressions for the transport coefficients in terms of the solution of the linearized transport equation are established. By treating the proper space–time transformations and the reflections on the same basis, the relativistic generalization of Curie's principle is derived from the relativistic and space reflection invariance of the microscopic interaction. It is shown that motion-reversal invariance leads to reciprocal relations between the transport coefficients, which correspond to cross effects. (auth)

17345 RELATIVISTIC KINETIC THEORY OF PARTICLES WITH A MAGNETIC DIPOLE MOMENT IN AN EXTERNAL ELECTROMAGNETIC FIELD. III. THE FIRST CHAPMAN–ENSKOG APPROXIMATION. van Weert, C. G. Kon. Ned. Akad. Wetensch., Proc., Ser. B; 73: 500-16(1970).

The relativistic transport equation for a gas mixture of magnetic dipole particles in an external field is linearized via the Chapman–Enskog method in such a way as to accommodate Senftleben-like effects. The solubility conditions for the linearized equation are discussed. Furthermore, the Gibbs relation, valid in the first Chapman–Enskog approximation, is derived. In the same approximation the entropy source strength is obtained as a bilinear expression in terms of the flows and the thermodynamic forces. (auth)

17346 GENERALIZATION OF BOLTZMANN'S KINETIC THEORY: THE LORENTZ GAS. Coste, J.; Peyraud, J. (Faculte des Sciences, Orsay, France). Phys. Rev., A; 3: 804-19(Feb 1971).

A new formulation is presented of the kinetics of the Lorentz gas, based on an analysis of statistically independent collisional events. A method is given in which the general collision operator is expanded in terms of functions of the density, and the μ^s approximation (μ is the density parameter and s is the dimensionality of the gas) is treated. The method is applied to the calculation of the self-diffusion coefficient. (auth)

17347 QUANTUM-MECHANICAL RELATION FOR A MAGNETIZED ELECTRON GAS. Canuto, V. (Goddard Space Flight Center, New York). Phys. Rev., A; 3: 648-50(Feb 1971).

The following theorem is proven: the xx and zz components of the electron energy–momentum tensor $t_{\mu\nu}$ and the magnetization M of an electron gas in a constant magnetic field B satisfy the relation $t_{zz} - t_{xx} = BM$. This relation is valid at any density, temperature, and magnetic field strength if the system is in thermal equilibrium. Since the electromagnetic energy–momentum tensor $t_{\mu\nu}$ is anisotropic itself, this relation makes the total energy–momentum tensor $T_{\mu\nu} = t_{\mu\nu} + \tau_{\mu\nu}$ become a scalar. Because t_{xx} and t_{zz} can simply describe the electron pressure in these directions, the above theorem states that the difference $p_{zz} - p_{xx}$ equals twice the magnetic field energy, since $M = 4\pi B$. (auth)

17348 POSSIBLE RELATIVISTIC GENERALIZATION OF THE FEYNMAN'S APPROACH TO THE QUANTUM MECHANICS. Mansurov, V. N. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; No. 6, 46-53(Nov-Dec 1968). (In Russian).

In the treatment considered here, the description is conducted in the language of the evolution parameter τ, which does not enter into the metrics of the 5-dimensional space $E_{4,1}$. The proposed scheme can find application out to ranges of $\sim 10^{-11}$ cm · 10^{21} sec. (tr-auth)

XUM

17349 STATUS OF THEORY OF WAVE PROPAGATION IN RANDOMLY INHOMOGENEOUS MEDIA. Barabanenkov, Yu. N.; Kravtsov, Yu. A.; Rytov, S. M.; Tatarskii, V. I. (Radiotechnical Inst., Moscow. Inst. of Atomic Physics, Moscow). Usp. Fiz. Nauk; 102: 1-42(Sep 1970). (In Russian).

A brief review is given of the theoretical methods and their applicability in studies of multiple wave scattering in the Markovian approximation, in the method of parabolic approximation, or for the summation of a series of perturbation theories developed originally in quantum electrodynamics. Wave propagation in inhomogeneous media, propagation of electromagnetic and mechanical waves, and the distribution of fluctuations in the medium are discussed. 542 references. (R.V.J.)

17350 UNCERTAINTY PRINCIPLE AND THE STATISTICAL INTERPRETATION OF QUANTUM MECHANICS. Ballentine, L. E. (Simon Fraser Univ., Burnaby, B. C.). Can. J. Phys.; 47: 2417-9(Nov 1969).

It is re-emphasized that the uncertainty principle applies to state preparation rather than to measurement. An objection by Robinson to the statistical interpretation of quantum mechanics is shown to be unjustified. (auth) (Canada)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 17403, 17407, and 17408.

17351 (UCRL-20120) PHYSICS REPORT, NOVEMBER 1969-JUNE 1970. (California Univ., Berkeley. Lawrence Radiation Lab.). Contract W-7405-eng-48. 115p. Dep. NTIS.

Research at the Lawrence Radiation Laboratory is reported. This research covers primarily experimental and theoretical high-energy physics, but also atomic, statistical, plasma and health physics, accelerator theory and operation and development, and computing and data handling are considered. Lists of publications are included. (J.F.P.)

17352 DETERMINATION OF THE UPPER LIMIT OF THE ABUNDANCE OF QUARKS WITH THE AID OF THE RESONANCE DIAMAGNETIC ELECTROMETER. Braginskii, V. B.; Kornienko, L. S.; Poloskov, S. S. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; No. 6, 110-11(Nov-Dec 1968). (In Russian).

Previous studies established a relative concentration of quarks less than one quark per 10^{17} nucleons. However, it was indicated that there was a possibility of increasing the figure up to 10^{22} nucleons by preliminary enrichment specimens of the substance. An attempt was made of obtaining a higher relative abundance of quarks by repeated measurements using the same specimen ($m \sim 1 \times 10^{-10}$ to 3×10^{-8} g graphite particles). The results showed that the abundance of quarks in solids did not exceed 10^{-18} per nucleon (with possible enrichment it was 10^{-23} per nucleon). (R.V.J.)

Electromagnetic

Refer also to abstracts 17658 and 18019.

17353 (JINR-E1-5256) NEUTRAL DECAY MODES OF THE η^0 PARTICLE. Strugalski, Z. S.; Chuvilo, I. V.; Gemesy, T.; Ivanovskaya, I. A.; Jablonski, Z.; Kanarek, T.; Krasnovsky, S.; Okhrimenko, L. S.; Pinter, G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1970. 19p. Dep. NTIS (U. S. Sales Only).

Results of investigation of the η^0 meson decay modes: $\eta^0 \rightarrow 2\gamma$, $\eta^0 \rightarrow \pi^0\gamma\gamma$, and $\eta^0 \rightarrow 3\pi^0$ are presented. The branching ratios of neutral decay modes were evaluated. (auth)

17354 THE POLARIZATION OF THE RECOIL PROTON IN ETA PHOTOPRODUCTION. Winstein, Bruce Darrell. Pasadena, Calif.; California Inst. of Tech. (1970). 105p. University Microfilms Order No. 70-24,580.

Thesis.

The recoil proton polarization is measured in the process $\gamma p \rightarrow p\eta$ at the 1.5 GeV Caltech electron synchrotron, at photon energies from 0.8 to 1.1 GeV, and at center-of-mass production angles around 90°. A counter-spark chamber array was used to determine the kinematics of all particles in the final state of the partial mode $\gamma p \rightarrow p\eta$ ($\eta \rightarrow 2\gamma$). The protons' polarization was determined by measuring an asymmetry in scattering off carbon. Analysis of 280,000 pictures yielded 2400 useful scatters with a background which was 30% of the foreground. The polarization results show a sizeable opposite parity interference at 830, 950, and 1100 MeV. (Diss. Abstr. Int., B)

17355 OMEGA MESON PHOTOPRODUCTION NEAR THRESHOLD. Taylor, Frank Eugene. Ithaca, N. Y.; Cornell Univ. (1970). 321p. University Microfilms Order No. 70-24,915.

Thesis.

The photoproduction of the omega meson was studied at two incident photon energies near threshold to measure the differential cross section of production off hydrogen and to measure the dependence of the omega spin polarization as a function of invariant 4-momentum transfer and as a function of incident photon energy. The data were analyzed in terms of the one pion exchange mechanism. The experimental apparatus consisted of a tagged photon beam to measure the energy of the incident photon, and three separate digitized wire spark chamber arms to measure the proton recoil angle and the two charged pion angles from the three pion decay of the omega. The recoil protons were identified and their recoil energy measured by a digitized pulse height counter system which used two scintillation counters, one to measure the dE/dx of the recoil proton and the other to measure E, the energy of the proton recoil. The tagged photon beam and the proton arm of the apparatus enabled the missing mass of the omega meson to be calculated. The pion spark chamber information enabled the 3-body decay events to be separated from the two-body decay events, thereby increasing the omega to background ratio. All data were recorded on magnetic tape and a preliminary analysis was performed by an on-line computer. (Diss. Abstr. Int., B)

17356 MEASUREMENT OF RECOIL-PROTON POLARIZATION IN NEUTRAL-PION PHOTOPRODUCTION AT 60 AND 90° USING A WIRE CHAMBER SYSTEM. Cheng, Shui-uh. Pasadena, Calif.; California Inst. of Tech. (1970). 194p. University Microfilms Order No. 70-24,570.

Thesis.

The recoil proton polarization was measured in the reaction $\gamma p \rightarrow \pi^0 p$ at the Caltech electron synchrotron at pion CM production angles around 60° and 90°, and photon energies from 0.65 to 1.375 GeV. Recoil protons were momentum-analyzed by a bending magnet along with a counter-wire spark chamber system. The polarization was determined by measuring the left-right asymmetry of p-C scatterings in a carbon plate range chamber. The data acquisition was handled by an on-line PDP-5 computer. Among 600,000 events taken, approximately 18,000 p-C scattered events survived the kinematics tests and requirements of analyzing power to yield 23 polarization points. The results indicate a strong angular dependence throughout the angular and energy regions covered. They agree very well with earlier results, but with improved statistics and with finer energy binning in the region of overlap. The π^0 photoproduction cross sections in the same kinematical region were also measured in the process. The agreement with known values is excellent. These results are interpreted in the framework of an isobar and partial wave model of π^0 photoproduction. (Diss. Abstr. Int., B)

17357 SOME YIELD MEASUREMENTS OF (γ,n) AND (γ,2n) PROCESSES IN GOLD AT ENERGIES BETWEEN 0.3 GeV AND 1 GeV. di Napoli, V. (Univ., Rome); Lacerenza, A. M.; Margadonna, D.; (and others). Lett. Nuovo Cim.; 1: 65-7(9 Jan 1971).

Values of cross sections per equivalent quantum for the ^{197}Au (γ,n)^{196}Au and the ^{197}Au(γ,2n)^{195}Au reactions are plotted as functions of the natural logarithm of the bremsstrahlung energy. These values were found from an exposure of gold to a 0.3- to 1-GeV bremsstrahlung beam at the Frascati Electron Synchrotron. (J.F.P.)

17358 PHOTOPRODUCTION OF ETA MESONS AT SMALL ANGLES. Booth, P. S. L.; Barton, J. S.; Carroll, L. J.; (and others) (Univ. of Liverpool). Nucl. Phys.; B25: 510-18(1971).

Measurements at small angles were made on the process $\gamma + p \rightarrow p + n$ in the region of the $P_{11}(1785)$ resonance at 1.22 and also at 1.51 and 1.85 GeV in order to test some previous theoretical assumptions. Two Cherenkov counter hodoscopes were used for this study, and the obtained differential cross sections are presented. The results near 1.22 GeV show the cross section decreased at small angles indicating destructive interference between the P_{11} resonance and the tail of the $S_{11}(1550)$. (J.F.P.)

17359 CONSERVATION OF S-CHANNEL HELICITY IN DIFFRACTIVE MESON PRODUCTION. Rabin, Monroe S. (Univ. of California, Berkeley). pp 143-63 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

Helicity conservation in the s-channel cms as observed in the diffractive process $\gamma p \rightarrow \rho^0 p$ is discussed. Also given is a short description of the method used to generate the incident photons, which are almost completely linearly polarized. (auth)

17360 EVIDENCE FOR THE $\omega \rightarrow 2\pi$ DECAY BY $\rho-\omega$ INTERFERENCE IN VECTOR MESON PHOTOPRODUCTION. Gabathuler, E. (Daresbury Nuclear Physics Lab., Warrington, Eng.). pp 645-54 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

Photon reactions with carbon were studied to investigate the $\omega \rightarrow 2\pi$ decay from $\rho-\omega$ interference in this reaction. A magnetic spectrometer was used for this study. The pion pair spectrum obtained shows definite evidence of $\rho-\omega$ interference at the ω mass. Various parameters are found. The absolute value of the differential cross section and the t-dependence of the ρ and ω production cross sections are consistent with other results. Also the mass spectrum from the electron pair experiment is given, and shows the large interference effect in the region of the ω mass. (J.F.P.)

XUM

17361 PHOTOPRODUCTION OF $K^+\Lambda$ AND $K^+\Sigma^0$ IN HYDROGEN BETWEEN 1.19 AND 1.68 GeV. Goeing, H.; Schorsch, W.; Tietge, J.; Weilnboeck, W. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nucl. Phys.; B26: 121-33(1971).

New measurements on the reactions $\gamma p \rightarrow K^+\Lambda$ and $\gamma p \rightarrow K^+\Sigma^0$ were performed at the DESY synchrotron at c.m. angles around 90° and photon lab. energies from 1.19 to 1.68 GeV. The produced K^+ mesons were analyzed by a magnet spectrometer, two threshold Cherenkov counters and a time-of-flight measurement. The obtained differential cross section data show a smooth energy behavior for the $K^+\Lambda$ production whereas for the $K^+\Sigma^0$ production the data trace out a bump at a c.m. energy $W \approx 1.9$ GeV. (auth)

17362 DETERMINATION OF THE CROSS SECTION OF TRIPLET PRODUCTION IN NUCLEAR EMULSIONS. Castor, J.; Augerat, J.; Devaux, A.; (and others) (Univ., Clermont-Ferrand, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.108-9 (May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

An experiment using emulsions was realized with photons produced by bremsstrahlung of electrons of 200 MeV/c. There were 18 452 events (pairs and triplets) analyzed. An experimental cross section in good agreement with previous theoretical predictions was obtained. (France)

17363 EXPERIMENTAL STUDY WITH A STREAMER CHAMBER OF THE PAIR PRODUCTION IN THE NUCLEUS AND ELECTRON FIELDS AT LOW ENERGY. Jousset, J.; Augerat, J.; Poureyron, A.; Roche, G.; Roussel, B. (Univ., Clermont-Ferrand, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.110-1 (May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The experimental set-up is briefly described. Some preliminary results are given for 2.62-MeV photons. (France)

17364 PRODUCTION OF MONOCHROMATIC POLARIZED PHOTONS. OPENING ANGLE OF ELECTRON PAIRS. ASYMMETRY RATIO. Augerat, J.; Castor, J.; Bui Tien, H.; (and others) (Univ., Clermont-Ferrand, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.112-13(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The electron pair production in nuclear emulsions by monochromatic linearly polarized photons was investigated. The differential cross section in opening angle was determined; the results are in good agreement with the theoretical calculations integrated over all particle energies. The experimental asymmetry ratio is given. (France)

Weak

17365 MUON DECAY DEEP UNDERGROUND. Reilly, Terence Douglas. Cleveland; Case Western Reserve Univ. (1970). 59p. University Microfilms Order No. 70-25,908.

Thesis.

A 2250-gal liquid-scintillation detector was operated for 1251.4 hr at a depth of 1568 hg of standard rock. The rate at which cosmic ray muons stop and decay in this detector was measured was 3.9 ± .4/day. This number agrees well with the values 3.6 ± .4/day predicted from the slope of the world-wide depth-intensity curve giving a direct indication that the cosmic ray particles deep underground are entirely muons produced in the atmosphere. The particles were identified as muons by their lifetime and the energy spectrum of their daughter electrons. Assuming a muon flux of the form, $I_v(h) \cos^n\theta$, the constants I_v and n were found to have the values 12.8 ± .9 $(m^2\text{-ster-hr})^{-1}$ and 3.1 ± .3, respectively. (Diss. Abstr. Int., B)

17366 CONCERNING THE $\bar{\nu}$ SCATTERING PROCESS. Akulov, V. P. (Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.); 12: 278-9(20 Oct 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 403-4 (20 Oct 1970).

An experiment is proposed in order to select one of the various models describing $\bar{\nu}$ + e scattering. A ferromagnetic target is used, and measurements are made of the number of recoil electrons at certain values of ζ, which is double the initial-electron spin projection on the incident antineutrino beam. (J.F.P.)

17367 INELASTIC SCATTERING OF 12 GeV/c MUONS. Coupat, B.; Michel, B.; Montret, J. C.; Vazeille, F. (Univ., Clermont-Ferrand, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.102-3(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Inelastic interactions induced by 12 GeV/c muons were studied by using K5 emulsions. The total muonproduction cross section is determined to be (13.4 ± 1.2) μb per nucleon. It seems it cannot be explained with the average scalar photon contribution obtained from electrons. (auth) (France)

Strong (Baryon-Induced)

Refer also to abstract 17827.

17368 (AD-712735) STRONG-INTERACTION EXPERIMENT ON MT. CHACALTAYA. Final Report. Yodh, Gaurang B. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Aug 1970. Contract F44620-69-C-0019. 21p. (AFOSR-70-2398-TR). NTIS.

The status of the experimental apparatus at the time of termination of the contract is summarized. The energy measuring device (calorimeter), which was constructed, is described. The status rest of the apparatus: beam telescope, electronics, spark chamber system, targets and transition radiation detector design is given. In addition, a complete list of all publications under this contract is included. (auth)

17369 (CERN/HERA-70-2) COMPILATION OF CROSS SECTIONS. I. PROTON INDUCED REACTIONS. Hansen, J. D.; Morrison, D. R. O.; Tovey, N. (European Organization for Nuclear Research, Geneva (Switzerland)); Flaminio, E. (Brookhaven National Lab., Upton, N. Y. European Organization for Nuclear Research, Geneva (Switzerland)). Oct 1970. 97p. Dep. NTIS.

A compilation of cross sections of reactions produced by protons on targets of protons, neutrons, deuterons and helium is presented. Graphs of the variation of cross section with incident laboratory momentum are plotted. Values for the rate of decrease of cross section with incident momentum are given. (auth)

17370 (JINR-P1-5570) INVESTIGATION OF THE REACTION $pp \rightarrow \pi^+ np$ AT 650 MeV. Zulkarneev, R. Ya.; Medved, S. V.; Nadezhdin, V. S.; Ovchinnikov, B. M.; Ozerov, E. B.; Poltavskaya, N. A.; Fedorov, O. Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

Using the equipment consisting of H_2-target, of a system of scintillation counters and of the filmless acoustic spark chamber on-line with the computer "Minsk-22", the triple differential cross sections in the reaction $pp \rightarrow \pi^+ np$ at 650 MeV were measured. The obtained experimental data are compared with the Sellery one-pion exchange model. (auth)

17371 (NP-18561) ANGULAR DISTRIBUTION OF THE NEUTRON-PROTON FINAL STATE INTERACTION IN THE REACTION d + p → p + p + n. Wick, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jul 1970. 101p. (In German). Dep. NTIS (U. S. Sales Only).

The three-nucleon reaction d + p → p + p + n was investigated in kinematic complete experiments with deuterons at 52 MeV energy. The special interest concerns a basic study of the neutron-proton final state interactions occurring in this reaction. The np final state interaction forms at small relative energies E_{np} of neutron and proton the dominating reaction mechanism. Both protons were detected under such angles in coincidence that np pairs with the relative energy $E_{rp} = 0$ could be observed. The analysis of the measurement results with help of the Watson-developed model of the final state interaction permits a distribution of the measured coincidence spectra into the reaction fractions which operate on the singlet and triplet states of the np subsystems (d^*). Angular distributions for both reactions $p + d \rightarrow p + d^*_{singlet} \rightarrow p + p + n$ (a) and $p + d \rightarrow p + d^*_{triplet} \rightarrow p + p + n$ (b) were first determined. The production angle θ_{d^*} in the center of gravity system, under which the np pairs were observed in ten different measurements, lie in the angle range between 55° and 152°. The results show that the effective cross sections for both reactions (a,b) depend on completely different ways on the production angle θ_{d^*}. The angular distributions of the elastic dp scattering and the reaction (b), which proceeds over the triplet state of the np subsystem, are therefore very similar. In a theoretical discussion, a relation was derived which makes it possible to predict the effective cross section of the three-particle reaction (b) quantitatively from the measured effective cross section of the elastic dp scattering. Both the angular dependence and the absolute size of the measured three-particle effective cross sections were represented very well with this relation. The effective cross sections of the np

singlet can be calculated only under backward angles in a similar manner. The discussion shows that the experimental study of the final state interaction can also yield information on cluster structures. The results obtained in this work are applied to complex nuclei. The analysis of the measurements by the model of the final state interaction yields a value for the np singlet state scattering length a_s. An average value of $a_s = -(22.7 \pm 0.5) \times 10^{-13}$ cm was obtained from three measurements at different angles. The comparison with the scattering length $a_s = (-23.68 \pm 0.03) \times 10^{-13}$ cm known from free np scattering shows that nucleon–nucleon scattering data can also be obtained from three-particle reactions with good accuracy. The systematic investigation under very different angle pairs leads simultaneously to the result that an accurate determination of the scattering length a_s in the reaction studied here is possible only under very favorable kinematic conditions. As soon as the amplitudes of various reaction mechanisms are superposed and therefore interference effects can play a role, the scattering lengths taken from the measurements deviate sharply from the values known from free np scattering. (tr-auth)

17372 (UCD-CNL-EX-130) STATUS OF NUCLEON–NUCLEON BREMSSTRAHLUNG. Brady, F. P. (California Univ., Davis. Crocker Nuclear Lab.). Dec 1970. Contract AT-11-1-GEN-10. 30p. Dep. NTIS.

The review of nucleon–nucleon bremsstrahlung covers the experimental techniques and a comparison of experiment and theory. It is concluded that off-shell effects are seen in ppγ and npγ, and discrepancies in the off-shell behavior of N–N interaction models are detected in ppγ. (J.F.P.)

17373 $\bar{p}p$ BACKWARD ELASTIC SCATTERING BETWEEN 0.70 AND 2.37 GeV/c. Yoh, John Kzun-ke. Pasadena, Calif.; California Inst. of Tech. (1970). 221p. University Microfilms Order No. 70-24,321.

Thesis.

The $\bar{p}p$ backward elastic scattering was measured for the cos θ_{cm} region between –1.00 and –0.88 and for the incident $\bar{p}$ laboratory momentum region between 0.70 and 2.37 GeV/c. These measurements, done in intervals of approximately 0.1 GeV/c, were performed at the Alternating Gradient Synchrotron at Brookhaven National Laboratory during the winter of 1968. The measured differential cross sections, binned in cos θ_{cm} intervals of 0.02, have statistical errors of about 10%. Backward dipping exists below 0.95 GeV/c and backward peaking above 0.95 GeV/c. The 180° differential cross section extrapolated from the data shows a sharp dip centered at 0.95 GeV/c and a broad hump centered near 1.4 GeV/c. The data were interpreted in terms of resonance effects and in terms of diffraction dominance effects. (Diss. Abstr. Int., B)

17374 REAL PART OF THE ELASTIC pn-SCATTERING AMPLITUDE AT ENERGY 4 GeV. Zolin, L. S.; Nikitin, V. A.; Sviridov, V. A.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 12: 330-3(Aug 1970). (In Russian).

Results are presented of experimental study of elastic proton–deuteron scattering at the proton energy of 4 GeV and at the momentum transfers $0.004 \leq |t| \leq 0.12$ (GeV/c)^2. With these data one is able to obtain the Re/Im ratio for the pd-scattering amplitude and to calculate, using the Glauber model, the proton–neutron ratio, $\alpha_{pn} = -0.52 \pm 0.18$ at $E_p = 4.0$ GeV. (auth)

17375 MEASUREMENT OF THE WOLFENSTEIN PARAMETER IN 605-MeV pn SCATTERING. Bilen'kaya, S. I.; Glonti, L. N.; Kazarinov, Yu. M.; Kiselev, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz.; 59: 1049-55(Oct 1970). (In Russian).

The Wolfenstein parameter A and polarization P in pn-scattering are measured at an energy of 605 MeV and angles of 55, 78, 94 and 125° (c.m.s.). The results are employed for determining with greater accuracy the two existing sets of phase shifts on basis of a phase shift analysis of NN-scattering at 630 MeV. The τ-test is employed for estimating the probability of an error of the first kind when solutions with a larger χ^2 are discarded. The probability was found to be a < 0.001%. (auth)

17376 SEARCH FOR T = 1 BOSONS NEAR 1 GeV IN THE REACTION pp → d + MM. Abolins, Maris A. (Michigan State Univ., East Lansing). pp 171-83 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

An experiment is described for the measurement of the differential cross sections of the reaction p + p → d + MM for deuterons produced at 180° in the cm system with laboratory momenta of 1.1 to 1.9 GeV/c. A spark chamber spectrometer was used to measure the deuteron momentum. The π^+, ρ^+ and $\pi(980)$ were found, and a limit was placed on the production of the narrow $\delta(962)$ in this reaction. (J.F.P.)

17377 T REGION. Kalbfleisch, G. R. (Brookhaven National Lab., Upton, N. Y.). pp 409-25 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

A review is given of evidence for meson production in the T region (mass = 2.19 GeV/c^2). The $\bar{p} + p \rightarrow \rho^0 + \rho^0 + \pi$ and the $\bar{p} + p \rightarrow K + \bar{K} + \omega$ interactions at 1.1 to 1.5 GeV/c are discussed. (J.F.P.)

17378 PREDICTION OF SLOPE CHANGES IN $\bar{p}p$ SCATTERING. Libby, L. M. (Univ. of Colorado, Boulder). pp 491-8 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

Using the exact relativistic relation between cross section and matrix element together with the well-known Bessel function parametrization of the scattering cross section, positions of slope changes in elastic scattering are predicted. For $\bar{p}p$ scattering, slope changes are predicted at momentum exchange values, $t \cong 0.10, 0.50, 1.24, 2.31, 4.50, \ldots$ (GeV/c)^2. Indeed the measured $(d\sigma/dt)_{90°}$ show distinct slope changes at ~0.50 and ~2.3 (GeV/c)^2. Correspondingly, nonstrange mesons are predicted to have masses 1940, 2190, 2580, 3060, 3570, 4140, ... MeV. (auth)

17379 INELASTIC HIGH-ENERGY PROTON–PROTON COLLISIONS. Akerlof, C. W. (Univ. of Michigan, Ann Arbor); Crabb, D. G.; Day, J. L.; (and others). Phys. Rev., D; 3: 645-63(1 Feb 1971).

The differential production cross section $d^3\sigma/d\Omega dp$ was measured for pions, kaons, protons, and antiprotons produced in 12.4 to 12.5-GeV/c proton–proton collisions. The dependence of these cross sections on the center-of-mass longitudinal and transverse momentum of π's, K's, and $\bar{p}$'s, and on $p_{c.m.}$ and $\theta_{c.m.}$ for protons, was systematically studied over much of the available phase space. The extracted proton beam of the Argonne zero-gradient synchrotron (ZGS) impinged on a liquid-hydrogen target. The scattered particles were detected by a spectrometer using magnets and scintillation and Cherenkov counters to identify and momentum-analyze these particles. A steering magnet allowed detection of particles produced at different laboratory angles without moving any of the apparatus. The incident proton intensity was determined by monitor counters calibrated using foil spallation techniques. The pion production cross section was well represented by a sum of two Gaussians in $p_\perp^2$: $d^2\sigma/d\Omega dp = Ae^{-15p_\perp^2} + Be^{-3p_\perp^2}$. The slope for large-momentum-transfer kaon production was also about 3 (GeV/c)$^{-2}$. The pion production cross section as a function of $p_\parallel^{c.m.}$ had a maximum at $p_\parallel^{c.m.} = 0$, possibly supporting a one-center model. Incorrect earlier measurements supporting a two-center model are discussed and corrected. The inelastic scattering cross section for protons also shows a less prominent forward peak and an $e^{-3p_\perp^2}$ dependence. This proton cross section also seems independent of inelasticity over a large range. (auth)

Strong (Meson-Induced)

Refer also to abstract 17483.

17380 (COO-1428-249) PRODUCTION OF K^+K^- AND pp PAIRS IN FOUR-BODY REACTIONS AT 13.1 GeV/c. Gaidos, J. A.; Mulera, T. A.; Ezell, C. R.; Lamsa, J. W.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.). [1970]. Contract AT(11-1)-1428. 17p. Dep. NTIS.

Data in the channels $\pi^+p \rightarrow \pi^+pK^+K^-$ and $\pi^+p \rightarrow \pi^+p\bar{p}p$ at 13.1 GeV/c are presented; the $\Delta^{2+}K^+K^-$ and $pK^+K^*(890)$ subsamples are discussed in terms of a double-Regge model. No resonance structure at M(pp̄p) = 3.755 GeV is observed. (auth)

17381 $K^+\pi^-$ SCATTERING AND RELATED EFFECTS IN THE REACTION $K^+p \rightarrow K^+\pi^-\Delta^{++}$ AT 5.43 GeV/c. Mercer, Robert Allen. Baltimore; Johns Hopkins Univ. (1969). 152p. University Microfilms Order No. 70-11,791.

Thesis.

This laboratory has now analyzed 200,000 pictures of K^+ meson–proton interactions occurring in the Brookhaven National Laboratory eighty-inch bubble chamber at an incident K^+ momentum of 5.43 GeV/c. This exposure corresponds to 0.167μb/event cross section, and there are 10,200 unambiguous fits to the reaction $K^+p \rightarrow K^+\pi^-\pi^+p$. The $K^+\pi^-\Delta^{++}$ substate of this final state was analyzed in terms of the one-pion exchange model, allowing a study of $K^+\pi^-$ virtual scattering. By performing a "Chew–Low extrapolation" from the physical region to the point where the exchanged pion becomes real, real Kπ scattering was also studied.

XUM

The resulting elastic scattering cross section agrees with the P-wave unitarity limit at 890 MeV; the δ_1^1 (notation: $\delta_{2I,2J}$) phase shift closely follows the expected Breir–Wigner behavior. The δ_0^1 phase shifts appears to rise to 90° in the vicinity of 1150 MeV, suggesting the existence of a broad resonance near that mass. The analysis does not permit a precise determination of the I = 3/2 phase shifts, but δ_2^1 appears to be small. A broad, low-mass enhancement, the N', appears in the $\Delta^{++}\pi^-$ mass spectrum of the $K^+\pi^-\Delta^{++}$ final state, similar to that observed in many pion–proton and proton–proton interactions. It is shown to be primarily or entirely a nonresonant effect; and, in fact, appears to be a manifestation of processes similar to one pion-exchange. The Ross–Yam model applied to the effect predicts mass and decay angular distributions qualitatively similar to the observed distributions. Earlier studies made on the first quarter of the film are also updated. The $K^{*0}\pi^+$ spectrum exhibits a broad peak which, in agreement with the earlier study, does not have the structure observed by CERN at 5.0 GeV/c. The spin of the $K^{*0}\pi^+$ enhancement is found to be 1^+ or 2^+. The preliminary study showed a narrow peak at 1920 MeV in the pK^+ mass distribution. With all the data included, this peak does not appear to be significant. (Diss. Abstr. Int., B)

17382 EXPERIMENTAL MESON SPECTROSCOPY. Second International Conference, Philadelphia, May 1–2, 1970. Baltay, Charles; Rosenfeld, Arthur H. (eds.). New York; Columbia University Press (1970). 674p. $15.00. (CONF-700525).

The conference included 34 papers seven of which were abstracted previously in NSA. For abstracts of these papers see CONF 700525 in a cumulative report number index. Separate abstracts were prepared for 27 papers. (J.F.P.)

For abstracts of individual papers see: 15939, 15940, 17359, 17360, 17376–17378, 17383–17391, 17433, 17483–17488, 17501, and 17639–17641.

17383 EXPERIMENTAL RESULTS ON THE $\omega-\rho$ INTERFERENCE EFFECT. Goldhaber, Gerson (Univ. of California, Berkeley). pp 59-128 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

The topics covered in this review include a probe for strong interactions, phenomenological expression for the mass spectrum, first-order theory, data fitting, the reaction $K^- + p \rightarrow \pi^+ + \pi^- + \Lambda$, $\pi + \pi$ and $K + \pi$ scattering, other hadron and photoproduction reactions, and the $\omega-\rho$ interference in lepton pair production. Also a summary of data on the $\omega-\rho$ interference including a comparison among experiments is given. (J.F.P.)

17384 $\rho-\omega$ INTERFERENCE in $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ AT 2.3 GeV/c. Hagopian, S.; Hagopian, V.; Bogart, E.; Selove, W. (Univ. of Pennsylvania, Philadelphia). pp 129-34 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

The constructive interference of the G-parity-violating decay mode $\omega \rightarrow \pi^- + \pi^+$ with $\rho^0 \rightarrow \pi^- + \pi^+$ decay in the reaction $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ in a bubble chamber is reported. The mass spectrum of $\pi^- - \pi^+$ is shown and described for this reaction. (J.F.P.)

17385 $S^*(1060) \rightarrow K_1^0 K_1^0$ AND HIGHER MASS $K_1^0 K_1^0$ RESONANCES. Beusch, W. (CERN, Geneva). pp 185-203 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

Data on the $S^* \rightarrow K_1^0 + K_1^0$ resonance produced in a spark chamber experiment on $\pi^- + p \rightarrow K^0 + K^0 + n$ interactions at 4 and 6.2 GeV/c are discussed. An increase in statistics allows an analysis of the $K_1^0 K_1^0$ system in more detail. The $K_1^0 K_1^0$ mass distribution, mass distribution in the S^* region, pion exchange and phase-shift analysis, and comparison with the $\pi\pi$ channel are considered. (J.F.P.)

17386 IS THE A_1 PRODUCED NON-DIFFRACTIVELY? Garelick, David (Northeastern Univ., Boston). pp 205-27 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

The present evidence for and against the nondiffractive production of the A_1 meson is reviewed. Several strong-interaction experiments in which enhancements in the A_1 region nondiffractively produced are reviewed. It is concluded that while evidence for A_1 nondiffractive production is increasing, additional experiments are needed for definitive evidence for the existence of the A_1. (J.F.P.)

17387 Q REGION OF $K\pi\pi$ MASS. Firestone, Alexander (Univ. of California, Berkeley). pp 229-74 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

The review of the Q region of the $K\pi\pi$ mass distributions covers K + d at 1 to 5.5 GeV/c and K + p at 1 to 15 GeV/c interactions, with kinematic and resonance interpretations. It is concluded that at high energies the Q consists of two peaks, one with M = 1250 ± 4 MeV and width = 182 ± 9 MeV, the other with M = 1400 ± 6 MeV and width 220 ± 14 MeV. (J.F.P.)

17388 L AND A_3 REGIONS OF $K\pi\pi$ AND 3π MASSES. Chien, Chih-yung (Johns Hopkins Univ., Baltimore). pp 275-302 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

A review is presented of the present situation of the L(1775) and $A_3(1640)$ enhancements in the $(K\pi\pi)^+$ and $(\pi\pi\pi)^+$ systems respectively. The L region in K + p and K + d interactions at high energies, and the A_3 region in π + p interactions at high energies are discussed separately. It is concluded that these enhancements were observed in all the diffractive processes studied. The only definite quantum number is the I-spin. The data indicate only one dominant decay mode: $L \rightarrow K(1420) + \pi$ and $A_3 \rightarrow f^0 + \pi$. (J.F.P.)

17389 DECAY ANALYSIS OF A_2^1 AND $A_2^{1'}$ IN THE CHANNELS $A_2^- \rightarrow K_1^0 K^-$, $A_2^- \rightarrow \rho^0\pi^-$, AND $A_2^- \rightarrow \eta\pi^-$. Baud, R.; Benz, H.; Bosnjakovic, B.; (and others). pp 311-30 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

The boson spectrometer was used to study the spin and parity from parameters of both halves of the split A_2 in the decays $A_2^- \rightarrow K_1^0 + K^-$, $A_2^- \rightarrow \rho^0 + \pi^-$, and $A_2^- \rightarrow \eta + \pi^-$. The results show that the spin and parity are 2^+ for A_2^1 and $A_2^{1'}$. (J.F.P.)

17390 U-MESON REGION. Smith, Gerald A. (Michigan State Univ., East Lansing). pp 427-36 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

A review of recent developments on the U meson region is given. The experiments studied are $\pi^- + p \rightarrow p + X^-$ interactions at 16 GeV/c and $\bar{p}$ + p and $\bar{p}$ + n interactions at 1.5 to 2.00 GeV/c. The U meson mass is found to be near 2370 MeV and the width is less than 60 MeV. However, it is not known why the total cross section is much broader. (J.F.P.)

17391 CHARGED NON-STRANGE BOSONS WITH MASSES HIGHER THAN 2.5 GeV. Baud, R.; Benz, H.; Bosnjakovic, B.; (and others). pp 437-55 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

Significant peaks (of more than four deviations significance) were found at masses of 2.62, 2.80, 2.88, 3.025, 3.075, 3.145, 3.475, and 3.535 GeV in the spectrum of charged nonstrange bosons X^- produced in the reaction $\pi^- + p \rightarrow p + X^-$. These masses were studied with the boson spectrometer. (J.F.P.)

17392 TOPICS IN K^+P INTERACTIONS. Goldschmidt-Clermont, Y. (CERN, Geneva). pp 309-410 of Topics in Theoretical Physics. /Riska, Dan Olof (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

A few topics illustrating the experimental problems in $K^+ + p$ interactions are discussed. The coverage includes three- and four-body and exotic final states. (J.F.P.)

17393 OBSERVATION OF THE $\bar{\Omega}$. Firestone, A.; Goldhaber, G.; Lissauer, D.; Sheldon, B. M.; Trilling, G. H. (Univ. of California, Berkeley). Phys. Rev. Lett.; 26: 410-13(15 Feb 1971).

An $\bar{\Omega}$ event was observed. The $\bar{\Omega}$ is produced in the reaction $K^+d \rightarrow \bar{\Omega}\Lambda\Lambda p\pi^+\pi^-$ at 12 GeV/c, and decays via the mode $\bar{\Omega} \rightarrow \bar{\Lambda}K^+$ The fitted mass for this particle is $M_{\bar{\Omega}} = 1673.1 \pm 1.0$ MeV. The $\bar{\Omega}$-production cross section is of the order of 0.1 μb. (auth)

17394 OBSERVATION OF THE K^0K^- MASS SPECTRUM IN THE A_2-MESON REGION. Foley, K. J. (Brookhaven National Lab., Upton, N. Y.); Love, W. A.; Ozaki, S.; (and others). Phys. Rev. Lett.; 26: 413-16(15 Feb 1971).

The effective-mass spectrum of $K^-K_1^0$ particles produced in the forward direction in the reaction $\pi^- + p \rightarrow K^- + K_1^0 + p$ at 20.3 GeV/c was measured. A broad peak corresponding to the A_2 meson is seen. The shape is fitted well by a single Breit–Wigner curve. A double-pole formula does not fit the data. A narrow peak in the K^-K^0 spectrum is seen at 1.425 GeV. (auth)

17395 Ω PRODUCTION IN $\pi^+d \rightarrow pp\pi^+\pi^-\pi^0$ AT 6.95 GeV/c. Matthews, J. A. J. (Univ. of Toronto); Prentice, J. D.; Yoon, T. S.; (and others). Phys. Rev. Lett.; 26: 400-3(15 Feb 1971).

The analysis of the reaction $\pi^+n \rightarrow \omega^0p$ at 6.95 GeV/c is reported. The absence of a dip in the differential cross section at $t \simeq -0.6$ $(GeV/c)^2$ and the nonzero values for the ω^0 spin-density matrix element ρ_{00} for $|t| < 1.4$ $(GeV/c)^2$ indicates that an unnatural-parity contribution to this process is still important at this energy. A simple Regge-pole model is found to represent the general form of the data. (auth)

17396 COHERENT PRODUCTION OF PIONS IN DEUTERIUM AT 5.4 GeV/c. Deery, B. J.; Biswas, N. N.; Cason, N. M.; (and others) (Univ. of Notre Dame, Ind.). Phys. Rev., D; 3: 635-42(1 Feb 1971).

The reaction $\pi^+d \rightarrow d\pi^+\pi^+\pi^-$ was investigated at an incident pion beam momentum of 5.4 GeV/c. The three-pion system is observed to be coherently produced off the deuteron target. The reaction is dominated by the quasi-three-body final state $d\rho^0\pi^+$. D^* enhancements are observed, but they appear to be the result of kinematic reflections from the $d\rho^0\pi^+$ system. The striking feature of this reaction is the presence of a broad, structureless, low-mass three-pion enhancement in the region between 0.9 and 1.5 GeV. (auth)

17397 OBSERVATION OF A 7π ENHANCEMENT AT 3.01 GeV. Yost, G. P.; Morris, W. A.; Albright, J. R.; Brucker, E. B.; Lannutti, J. E. (Florida State Univ., Tallahassee). Contract AT(40-1)-3509. Phys. Rev., D; 3: 642-4(1 Feb 1971).

In an 11.0-GeV/c π^+p exposure in the BNL 80-in. hydrogen-filled bubble chamber, 171 events were found that fit the reaction $\pi^+ + p \rightarrow 4\pi^+ + 3\pi^- + \pi^0 + p$. The $(4\pi^+3\pi^-)$ and $(3\pi^+3\pi^-\pi^0)$ effective-mass spectra both show a statistically significant peak at 3.013 GeV with a width less than 0.04 GeV. This enhancement agrees well both in position and in width with one of the peaks observed in a CERN missing-mass spectrometer experiment. (auth)

17398 CHARACTERISTICS OF COHERENT INTERACTIONS OF π^- MESONS ON EMULSION NUCLEI AT 60 GeV. Vinitskii, A. Kh.; Voinov, V. G.; Strel'tsov, I. S.; Takibaev, Zh. S.; Chasnikov, I. Ya. (Inst. of Nuclear Physics, Alma-Ata, USSR). Dokl. Akad. Nauk SSSR; 194: 544-6(21 Sep 1970). (In Russian).

Coherent generation of particles in high-energy hadron interaction with silver and carbon nuclei were studied using the Serpukhov 60 to 70 GeV accelerator. The work was confined to the 3- and 5-particle events, in the BR-2 nuclear emulsion, found along primary pion 870 m tracks. Measurements of multiple scattering were used for determining the momenta of the secondary particles in the 3- and 5-particle interactions where $\Sigma \sin \theta_i \leq 0.3$ (θ_i is the spatial angle of the secondary particle emission). The scattering was measured using semiautomatic microscope. Graphical data are given for the determining by momenta of 54 particles with the scattering length exceeding 5 cm. The mean magnitude of the momentum was in good agreement with the energy of the incoming pion. It was found that the cross section of coherent formation of the $\pi^+\pi^-\pi^-$ system in the finite state increased with the increase of the primary particle energy while the maximum of the distribution according to the effective mass of the system remained in the same region as at 17 GeV. The number of the 5-particle coherent interactions increased. At 70 GeV energy the fraction of 5-particle coherent interactions in comparison with the 3-particles is 70%. (R.V.J.)

17399 STUDY OF THE L-MESON IN 10 GeV/c K^+p INTERACTIONS. Colley, D. C. (Univ. of Birmingham, Eng.); Jobes, M.; Kenyon, I. R.; (and others). Nucl. Phys.; B26: 71-82(1971).

A study of the L-meson in four-, five-, and six-body final states from the interaction of K^+ mesons with protons at 10 GeV/c is reported. Strong evidence for decay of the L-meson into $K^*(890)\pi$ and $K^*(890)\rho$ as well as for decay into $K^*(1420)\pi$ is found. Also, evidence for decay into $K^*\omega$ is found. (auth)

17400 REACTION $\pi^+p \rightarrow f^0\Delta^{++}$ AT 13.1 GeV/c. Gaidos, J. A.; Ezell, C. R.; Lamsa, J. W.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; B26: 225-30(1971).

Data for the reaction $\pi^+p \rightarrow f^0\Delta^{2+}$ at 13.1 GeV/c are presented and discussed within a Reggeized pion exchange model with absorption. (auth)

17401 HIGH MULTIPLICITY π^+p INTERACTIONS AT 8 GeV/c INCOMING π^+ MOMENTUM. Czyzewski, Oleg. Zesz. Nauk. Akad. Gorn.-Hutn. Krakow., Rozpr.; 208: No. 2, 65-77(1969). (In Polish).

The high multiplicity interactions of 8-GeV/c positive pions with protons were investigated by means of a 2-m hydrogen bubble chamber exposed to a beam of pions produced from an internal target in the CERN P. S. 200,000 frames were scanned for the eight- and ten-prong events. The strong production of the ω^0 and ρ mesons is observed. The N^*_{1236} resonance is not observed, but it can be due to the unfavorable shape of the phase space. The cross sections for all investigated reaction channels and for resonance production are given. In the distributions of the $(N + 7\pi)$ combination mass a sharp maximum was noticed, which was considered as the evidence of the production of a heavy isobar with the mass M = (3.695 ± 0.015) GeV and isospin $T = \frac{1}{2}$. The angular correlations between pions appear strongly in the investigated reactions and depend on pion energy in the reaction CMS. The study of single-particle distributions shows that in the investigated material the central, statistical interactions dominate over the peripheral processes. (auth)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 18020.

General

Refer also to abstracts 17351 and 18174.

17402 (COO-264-561) DISPERSION THEORY AND CURRENT ALGEBRA. Lam, Yuk-Ming P. (Chicago Univ., Ill.). Oct 1970. Contract AT(11-1)-264. 70p. (EFI-70-59). Dep. NTIS.

Lorentz invariance and the basic assumption in dispersion theory that the matrix element of a retarded or advanced commutator of local fields is an analytic function of the energy variable, are seen to determine the method of handling the dispersion integral, and to require the matrix element to consist of terms, each being a product of at most two poles or integral thereof. This method is used to study current-algebra commutators with the consequence that the widely employed assumption of single-pole dominance for the spin-one parts of vector or axial-vector current is inconsistent with current-algebra. Some aspects of the K_{l3} form factors are also discussed. (auth)

17403 (IS-2300, pp 187-251) PHYSICS DIVISION. Barnes, R. G.; Brun, T. O.; Clem, J. R.; (and others) (Ames Lab., Iowa).

From Ceramic Engineering, Chemical Engineering, Chemistry, Mathematics and Computer Science, Metallurgy, Physics, and Reactor Divisions annual summary research report, July 1969–June 1970.

Abstracts of research in high-energy physics, medium- and low-energy physics, and solid-state physics are presented. (J.F.P.)

17404 SPIN ALGEBRAS AND REPRESENTATIONS OF THE POINCARE GROUP. Braathen, Hans Joergen. Cleveland; Case Western Reserve Univ. (1969). 120p. University Microfilms Order No. 70-25,842.

Thesis.

The spin of an elementary particle is characterized in terms of the generators of the Poincaré group. A spin algebra, related to the canonical spin algebra is constructed from the generators; the helicity operator is an element of this algebra, a second is constructed so that it commutes with the generator for a Lorentz transformation along the z-axis. A basis for a representation space is chosen in which the generators for space translations and this new spin algebra element are diagonal. The generators of the Poincaré group are represented in this new basis. The basis is proven to be equivalent to that defined by Kotański in which the crossing relations are diagonal. The representation has a number of peculiar properties which are discussed. A second basis is defined and one attempts to exploit the azimuthal symmetry in any scattering experiment. The Poincaré algebra is represented in this basis both for zero and nonzero mass. Singularities connected with the helicity convention are discussed. The discrete elements of the Poincaré group are represented in both bases and these bases are connected with the helicity basis defined by Jacob and Wick. Finally, the S-matrix is constructed and the crossing relations in the bases are discussed. (Diss. Abstr. Int., B)

17405 STATE OF UNPOLARIZED RADIATION. Agarwal, G. S. (Univ. of Rochester, N. Y.). Lett. Nuovo Cim.; 1: 53-6 (9 Jan 1971).

Some implications of a previous definition of unpolarized radiation are examined. This definition states that the density operator characterizing the state of unpolarized radiation remains invariant under arbitrary phase changes introduced in any two linear polarized orthogonal components, and under rotation of the two orthogonal components by an angle about the direction of propagation. The general form of the phase-space distribution functions, which are obtained from the density operator via normal and antinormal rules of mapping, is obtained for radiation that is unpolarized in their sense. A monochromatic beam of radiation is considered. (J.F.P.)

XUM

17406 TEORIA PARTICULELOR ELEMENTARE. (Theory of Elementary Particles). Novacu, Valeriu; Vescan, Toma. Bucuresti; Editura Academiei Republicii Socialiste Romania (1970). 695p.

The topics discussed include symmetry problems, analyticity in strong interaction theory, relativistic formulation of scattering problems, the relation between the field theoretical concepts and dispersion relations, analytic S-matrix theory, and weak interaction theory. (J.F.P.)

17407 HIGH ENERGY PHYSICS INDEX. VOLUME 8, NO. 26, 1970. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 74p.

17408 HIGH ENERGY PHYSICS INDEX. VOLUME 9, NOS. 1–2, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 71p.

17409 OPTIMAL COORDINATE REPRESENTATIONS FOR PARTICLE REACTIONS. Moravcsik, Michael J. (Univ. of Oregon, Eugene). Nucl. Phys.; A160: 569-76(1971).

It is desirable to find coordinate representations for particle reactions which are optimally convenient in terms of the simplicity of the relation between observables and the bilinear products of invariant amplitudes, and in terms of the constraints imposed by symmetry laws. In addition, one also wants compatibility with experimentally convenient coordinates. The types of coordinate systems satisfying the above requirements are constructed. It is shown that if all spacial symmetry operations are considered, the only simple coordinate system is the previous l, m, n, system. With a more modest set of symmetries, however, such as P, T, and PT, other systems are also suitable which might be more convenient from an experimental point of view. (auth)

17410 TOPICS IN THEORETICAL PHYSICS. Proceedings of the Fourth Finnish Summer School in Theoretical Physics, Held at Liperi, Finland, 1968. Riska, Dan Olof (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969). 415p. $25.00.

The conference included 10 papers. Separate abstracts were prepared for all papers. (J.F.P.)

For abstracts of individual lectures see: 17392, 17411, 17470–17472, 17481, 17482, 17502, 17503, and 17528.

17411 SOME APPLICATIONS OF THE DISPERSION SUM RULES IN ELEMENTARY PARTICLE PHYSICS. Faustov, Rudolf (Joint Inst. for Nuclear Research, Dubna, USSR). pp 231-64 of Topics in Theoretical Physics. /Riska, Dan Olof (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The use of dispersion sum rules for elementary particles is reviewed. Local currents and dispersion sum rules, asymptotic properties of the invariant amplitudes, mass formulas in broken SU(3) symmetry, and the photoproduction of mesons on baryons are covered. Also the Cabibbo–Radicati and Adler–Weisberger relations are discussed. (J.F.P.)

17412 UNITARITY CONDITION AND DECREASE OF DIFFERENTIAL CROSS SECTION OF MULTIPARTICLE PRODUCTION WITH ENERGY INCREASE. Ezhela, V. V.; Logunov, A. A.; Mestvirishvili, M. A. (Inst. of High Energy Physics, Moscow). Teor. Mat. Fiz.; 6: 42-54(Jan 1971). (In Russian).

Proceeding from the analytic properties of the inelastic process amplitude and unitarity condition it is shown that the differential cross section of multiparticle production for fixed θ and $\varphi \neq 0, \pi$ decreases with energy increase. The upper bound of the decrease is established. (auth)

17413 ANALYTICAL STRUCTURE OF THE SUPERPROPAGATOR IN THE COUPLING CONSTANT. Volkov, M. K. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 6: 21-7(Jan 1971). (In Russian).

The analytical structure of the super-propagator in the coupling constant for particles with nonzero rest mass is revealed and the approximate formula for the super-propagator well describing it for small values of the momentum and coupling constant is obtained. (auth)

17414 QUASI-FREE STATES OF THE C* ALGEBRA OF COMMUTATION RELATIONS. I. Kholevo, A. S. (Steklov Mathematical Inst., Moscow). Teor. Mat. Fiz.; 6: 3-20(Jan 1971). (In Russian).

Primary quasi-free states of the C^*-algebra of the CCR are investigated. Among the other results, the theorem is proved which gives the necessary and sufficient conditions of the quasi-equivalence of the states considered. (auth)

17415 MONTE CARLO GENERATION METHOD WITH IMPORTANCE SAMPLING FOR HIGH-ENERGY COLLISIONS OF HADRONS. Kittel, W. (CERN, Geneva); Van Hove, L.; Wojcik, W. Comput. Phys. Commun.; 1: 425-36(Dec 1970).

A computer program is described based on a Monte Carlo integration method for the analysis of high-energy hadron interactions. The Monte Carlo program is based on the generation of phase space points with importance sampling. The method uses as integration variables the momenta of the outgoing particles in the cms system distinguishing between their longitudinal components, which grow with energy, and their transverse ones, which remain essentially constant at all energies. The program GENIS is in FORTRAN IV and is written for the CDC 6600 computer. The structure of the program and special aspects are described. (J.F.P.)

17416 GENERALIZATION OF COMPOSITENESS CONDITIONS. Yoshimura, T. (Univ. of Adelaide). Nucl. Phys.; B26: 215-24 (1971).

The Lagrangian theory of composite particles is extended by the introduction of polynomials of elementary field operators so as to include a class of dynamically generated poles which cannot be represented as composite particles with Lagrangians considered so far. (auth)

17417 CONTINUOUS BASES FOR UNITARY IRREDUCIBLE REPRESENTATIONS OF SU(1,1). Lindblad, G.; Nagel, B. (Royal Inst. of Tech., Stockholm). Ann. Inst. Henri Poincare, Sect. A; 13: No. 1, 27-56(1970).

The unitary irreducible representations (UIR) of SU(1,1) are studied in two different continuous bases obtained by diagonalizing a noncompact generator belonging to the hyperbolic and parabolic class, respectively. The space of differentiable vectors of a UIR and its dual containing the generalized eigenvectors of the noncompact generators are described in the discrete and continuous bases. The matrix elements of finite transformations and generators are given. (France)

17418 THEOREMS ON HIGH ENERGY COLLISIONS OF ELEMENTARY PARTICLES. Eden, R. J. (Cavendish Lab., Cambridge, Eng.). Rev. Mod. Phys.; 43: 15-35(Jan 1971).

This review gives a survey of the following topics: results on analyticity and asymptotic growth that follow from axiomatic quantum field theory, bounds and inequalities involving cross sections at high energies, theorems and relations between cross sections requiring special assumptions, and a discussion of the Pomeranchuk theorem and of experimental and theoretical results that would hold if it were violated. (auth)

17419 ROLE OF INELASTIC PROCESSES AT HIGH ENERGIES AND THEORY OF FIREBALLS. Dremin, I. M.; Roizen, I. I.; Chernavskii, D. S. (Lebedev Inst. of Physics, Moscow). Usp. Fiz. Nauk; 101: 385–428(Jul 1970). (In Russian).

In the review the questions of the theory of inelastic processes and also the relation between the inelastic properties and the elastic interactions at high energies, which are dependent on these properties, are discussed in detail. The main properties of the inelastic interaction are the existence of the fireball-type processes with the fireball number increasing with the total energy of the interaction, and the asymptotic increase of the cross sections of peripheral interactions. The corresponding elastic scattering characteristic is that first the vacuum singularity, which determined its asymptote, must be moving. However, this singularity cannot be a Pomeranchuk pole (it must either be a weaker pole, or located at $t = 0$ to the left of the point $l = 1$). Second, the elastic scattering at arbitrary angle is determined, in the final account, by the inelastic process. All of the enumerated properties follow naturally from the correct Bethe–Salpeter equation and the unitary ratios. The relation among various schemes of description of inelastic interactions at high energies is discussed. (tr-auth)

17420 USE OF COLLINEAR AND DOUBLE O(2,1) VARIABLES FOR SINGLE-PARTICLE SPECTRA. Tan, Chung-i (Brown Univ., Providence). Phys. Rev., D; 3: 790-2(1 Feb 1971).

Various different sets of variables used for single-particle inclusive experiments are grouped into two general types. The first type specifies momenta in collinear frames; and the other, double O(2,1) variables, specifies momenta in the rest frame of the produced particle. Advantages of each set of variables are briefly mentioned. Useful relations, exact as well as asymptotic, between various sets are provided. (auth)

Electromagnetic

Refer also to abstracts 17562 and 17572.

17421 (LNF-70/47) SHORT-RANGE DYNAMICAL CORRELATIONS FROM ELASTIC AND QUASIELASTIC SCATTER-

ING OF HIGH-ENERGY ELECTRONS. Malecki, A.; Picchi, P. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 16 Oct 1970. 6p. Dep. NTIS (U. S. Sales Only).

The influence of short-range correlations on elastic and quasi-elastic electron scattering on ^{4}He is compared. (auth)

17422 (SU-1206-236) ON THE Q^2-DEPENDENCE OF THE INELASTIC e-p SCATTERING STRUCTURE FUNCTIONS. Gardiner, C. W. (Waikato Univ., Hamilton (New Zealand)); Majumdar, D. P. (Syracuse Univ., N. Y. Dept. of Physics). [1970]. 31p. (NYO-3399-236). Dep. NTIS.

It is pointed out that for $\omega = (2M\nu/Q^2) \geq 4.5$ and $Q^2 < 2$ GeV^2, the structure function $\nu W_2(\nu,Q^2)$ of the inelastic e-p scattering increases as Q^2 increases at a fixed value of ω. To understand the Q^2-dependence of the data, νW_2 is then analyzed from several theoretical points of view. In particular the parton model, the Regge-pole model and the field theoretic calculations are discussed. (auth)

17423 HARD-PION CURRENT ALGEBRA AND THE REACTION $e^+ + e^- \rightarrow A_1^\pm + \pi^\mp$. Vaughn, M. T. (Univ., Vienna); Polito, P. J. Lett. Nuovo Cim.; 1: 74-6(9 Jan 1971).

It is pointed out that the colliding beam reactions $e^+ + e^- \rightarrow A_1^\pm + \pi^\mp$ can provide a test of hard-pion current algebra models which give definite predictions for the reaction cross section and angular distributions. The predictions for such cross sections and angular distributions are given for the energy range from 1.4 to 6.0 GeV. Also the predicted values of the $\pi^+ - \pi^-$ production cross sections are given, which serve as a check of the assumed vector current propagator. (J.F.P.)

17424 DUALITY DIAGRAM AND REGGE CUTS IN K^+ PHOTOPRODUCTION. Capella, A.; Tran Than Van, J. (Laboratoire de Physique Theorique et Particules Elementaires, Orsay, France). Lett. Nuovo Cim.; 4: 1199-1206(19 Dec 1970).

A model consisting of an exchange-degenerate K^*-K^{**} Regge contribution and its corresponding cut is suggested to parametrize the data on K^+A and $K^+\Sigma^0$ photoproduction on polarized protons at 5 to 16 GeV. Two different parametrizations are used—the first using the asymptotic behavior for the cut contribution and the second using a nonasymptotic behavior. (L.B.S.)

17425 MODEL FOR ELECTROPRODUCTION AND PHOTOPRODUCTION OF PIONS NEAR THE N*(1236) RESONANCE. Cochard, G.; Kessler, P. (College de France, Paris). Lett. Nuovo Cim.; 4: 1191-5(19 Dec 1970).

An attempt is made to interpret the experimental data for photoproduction and electroproduction of pions near the N*(1236) resonance, using a simple model based on Feynman diagrams for a resonant term, Born terms, and terms with ρ and ω exchange. (L.B.S.)

17426 SHORT-RANGE DYNAMICAL CORRELATIONS FROM ELASTIC AND QUASI-ELASTIC SCATTERING OF HIGH-ENERGY ELECTRONS. Malecki, A. (Instytut Fizyki Jadrowej, Krakow); Picchi, P. Lett. Nuovo Cim.; 1: 41-4(9 Jan 1971).

Elastic and quasi-elastic scattering are discussed using the same model for internucleon correlations in both cases. Thus the relative merits of this model in predicting the cross sections for the two processes can be evaluated. Numerical results for the ^{4}He nucleus are given. The effects of the short-range correlations on elastic and quasi-elastic cross sections are compared, and the applied correlations are visualized by presenting the separation density which is the probability of finding a nucleon pair with a certain mutual distance and momentum distribution. It is concluded that elastic scattering is preferred for studying short-range correlations, since it is free of final-state interactions and electroproduction complications. However, correlation effects in quasi-elastic scattering are more difficult and must be preceded by a careful separation between nuclear and meson physics. (J.F.P.)

17427 EFFECT OF FINITE DIMENSIONS OF NUCLEUS WITH MAGNETIC DIPOLE MOMENT ON PHOTOPRODUCTION OF PAIRS WITH CALCULATION OF PARTICLE POLARIZATION. Kerimov, B. K.; Ablakulov, Kh. A. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 11: 15-25(Jan-Feb 1970). (In Russian).

Formulas for the angular distribution and the degrees of longitudinal polarization of positron pairs are obtained in the Born approximation. The pairs are formed range-polarized by photons in the field of a nucleus with a magnetic dipole moment. The mean-square radius and the fourth moment of the nuclear charge- and magnetic-moment-density distributions are calculated, and the resulting effects on the spectra of the positron pairs are studied. (tr-auth)

17428 INTEGRAL EQUATION FOR A PARTICLE IN AN ELECTRIC FIELD. Moyer, Curt A. (State Univ. of New York, Stony Brook). Ann. Phys. (N. Y.); 61: 242-59(Nov 1970).

An integral equation is presented appropriate to a particle bound by an attractive force when a uniform electric field is applied. Two types of states arise corresponding to the homogeneous and inhomogeneous integral equations, respectively. The physical distinction between them leads directly to a criterion for electrical breakdown. The ideas are illustrated for an electron bound by a one-dimensional square well. (auth)

17429 PARITY RULE AND HELICITY CONSERVATION IN DIFFRACTION DISSOCIATION. Barmawi, M. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 4: 1235-9(19 Dec 1970).

The parity rule proposed by Morrison (Phys. Rev., 165: 1699 (1968)) and the s-helicity conservation proposed by Gilman et al. (Phys. Lett., 31B: 387(1970)) for diffraction dissociation processes are discussed. The L–S coupling scheme is introduced to describe the coupling between the Regge pole to the external particles with spin. It is shown that the parity rule follows from the L–S scheme. From the study of ρ^0 photoproduction it is shown that the s-helicity conservation in the forward direction follows from the analyticity properties of the Regge exchange amplitude. (L.B.S.)

17430 BJORKEN LIMIT IN A SIMPLE MODEL OF ELECTRON–NUCLEON INELASTIC SCATTERING. Contogouris, A. P. (McGill Univ., Montreal). Lett. Nuovo Cim.; 4: 1213-19(19 Dec 1970).

The scaling behavior of the structure functions for electron–nucleon inelastic scattering is studied by means of simple dispersion-theoretic models. The Bjorken-limit behavior in these models is related to the singularity structure in complex angular momentum of the hadron amplitudes. The models suggest that Regge-pole behavior leads to exact scaling, and that Regge cuts lead to approximate scaling. The Bjorken-limit behavior of the structure function for electron–positron annihilation is also studied. (L.B.S.)

17431 MASS OPERATOR AND EXACT GREEN'S FUNCTION OF AN ELECTRON IN AN INTENSE FIELD. Ritus, V. I. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 12: 289-91(20 Oct 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 416-18(20 Oct 1970).

The structure and properties of the mass operator and of the eigenfunctions and Green functions of an electron in a crossed field are described. It is noted that these functions are exact in terms of the external and radiation fields. (J.F.P.)

17432 ANAPOLE MOMENT OF THE DEUTERON. Zhirkov, L. F.; Satsunkevich, I. S. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 3, 123-5(1970). (In Russian).

For the process ed → ed, consequences were examined which follow from the premise concerning the existence of a deuteron anapole moment. It is shown that the angular distribution asymmetry of the electrons, which were scattered on deuterons polarized in the reaction plane, does not exceed the magnitude 10^{-2}. (tr-auth)

17433 PHOTOPRODUCTION OF HIGH MASS DIPION PAIRS AT 15 GeV. Bulos, F. (Stanford Univ., Calif.); Busza, W.; Giese, R.; (and others). pp 469-75 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

For the study of the photoproduction of high-mass dipion pairs a 16-GeV bremsstrahlung beam was incident on a beryllium target. A total of 620 events were observed in the intervals $E_{\pi\pi} \leq 14$ GeV. The ratio of the forward cross section to the cross section at $t - t_m = -0.12$ was plotted versus the mass. It is noted that the observed variation is not explained by the diminution of the nuclear form factor as the dipion mass increases. Also the yield versus the mass of the dipion is shown for $t - t_{min} \leq -0.046$. It is indicated that the general features of the mass and momentum transfer distribution are explained by an interfering rho production and Drell-type dipion production. The peak cross section for the photoproduction of any state in this high-mass region is estimated. (J.F.P.)

17434 INELASTIC ELECTRON–PROTON SCATTERING AND A SUM RULE FOR THE SCHWINGER TERM. Gupta, V.; Rajasekaran, G. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., D; 3: 677-81(1 Feb 1971).

It is shown that the form of the one-particle expectation value

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of the Schwinger term in the equal-time commutator of the electromagnetic current and change densities is determined by relativistic covariance. This allows a sum rule to be derived for the one-proton expectation value of the Schwinger term involving the structure function W_2 measured in inelastic electron–proton scattering. From this sum rule for the Schwinger term the sum rule $(d/dq^2)\int_0^\infty d\nu\,[\nu W_2(q^2,\nu)/q^2] = 0$ can be obtained, where q^2 is the square of the four-momentum transfer, and ν is the energy loss of the electron in the laboratory frame. This equation is compared with the recent experimental data using "scale invariance." It is found from this comparison that this sum rule is reasonably well satisfied. (auth)

17435 NUCLEON MASS DIFFERENCE AS RADIATIVE CORRECTION. Granovskii, Ya. I. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 68-72(Mar-Apr 1968). (In Russian).

The starting point of the discussion is the premise that the isotopically invariant part of the nucleon mass is described by the self-energy diagram of the πN intermediate state. The mass difference emerges as a result of radiative corrections to the πNN vertex. The vertex is considered as the analytical function of the nucleon external mass and is calculated by the dispersion method. It is determined that the mass difference is stipulated by the electromagnetic correction to the pseudovector part of the nucleon current. The calculation leads to the result $M_n - M_p = 2Me^2g^2(4\pi)^{-1} = 1.27$ MeV which agrees well with the experimental value of 1.29 MeV. (tr-auth)

17436 METHOD FOR MEASURING THE PHOTON–PHOTON TOTAL CROSS SECTION. Stodolsky, Leo (Stanford Univ., Calif.). Phys. Rev. Lett.; 26: 404-7(15 Feb 1971).

In the interaction of a high-energy particle with a proton or nucleus, the recoil spectrum of the target at very low momentum transfer is related simply to the total cross section of the incident particle with the photon. Estimates of the size of the effect plus recent developments in low-recoil techniques suggest that measurement of the photon–photon as well as the π- and K-photon cross sections may be possible. (auth)

17437 QUANTUM THEORY OF RELATIVISTIC ELECTRON MOTION IN AXIALLY SYMMETRIC FOCUSING-TYPE MAGNETIC FIELD. Zhukovskii, V. Ch.; Kholomai, B. V.; Sokolov, A. A.; Ternov, I. M. (Moscow State Univ.). Teor. Mat. Fiz.; 6: 78-86(Jan 1971). (In Russian).

In the harmonical oscillation approximation the solution of the Dirac equation is found for the electron moving in axial-symmetric focusing magnetic field. The radiational polarization effect is investigated with the aid of the wave functions obtained. (auth)

17438 COHERENT STATES AND THE EXCITATION OF CHARGED PARTICLE IN CONSTANT MAGNETIC FIELD BY MEANS OF THE ELECTRIC FIELD. Malkin, I. A.; Man'ko, V. I. (Inst. of Physics and Tech., Moscow). Teor. Mat. Fiz.; 6: 71-7(Jan 1971). (In Russian).

New integrals of motion, coherent states, Green function and amplitudes of the transitions between Landau levels are constructed for the nonrelativistic charged particle moving in the stationary and spatially uniform magnetic field and in the changing electric field which is perpendicular to the magnetic one. The dynamical symmetry group is shown to be the group U(2,1). (auth)

17439 STICHEL THEOREM IN PSEUDOSCALAR MESON PHOTOPRODUCTION. Bajpai, R. P. (Univ. of Manchester, Eng.). Nucl. Phys.; B26: 231-6(1971).

It is proved that Stichel's theorem is valid in a much wider context than initially supposed. The nature of the assumptions involved is investigated and the correction terms are obtained. (auth)

17440 ASYMMETRY IN ELECTROPRODUCTION OF PIONS BY POLARIZED ELECTRONS. Gehlen, G. v. (Univ., Bonn). Nucl. Phys.; B26: 141-50(1971).

In view of the progress recently achieved in the preparation of polarized electron sources, electroproduction by polarized electrons is studied. It is shown that in addition to the four structure functions $\tilde{W}_1 \ldots \tilde{W}_4$ which can be determined from coincidence experiments with unpolarized particles, a fifth structure function $\tilde{W}_5$ can be measured if the incident electron is polarized. For π^0 production in the region of the $N^*(1238)$ the asymmetry of the pion distribution due to the electron polarization turns out to be approximately proportional to $\mathrm{Re}S_{0+}$. The most convenient kinematical configuration is for $\epsilon \approx \frac{1}{2}$. Asymmetries only up to $\approx 15\%$ are predicted. The results also apply to pion production by polarized muons from pion decay. (auth)

17441 DEEP-INELASTIC ELECTRON–PROTON SCATTERING IN A PARTON–DUALITY MODEL. Ezawa, Zyun F. (Tokyo Univ.). Nucl. Phys.; B26: 195-202(1971).

Based upon the parton view, the electromagnetic interaction is incorporated into strong-interaction physics, to which the idea of duality is applicable. By assuming a suitable form for parton–proton scattering, structure functions for the deep-inelastic electron–proton scattering are studied, and shown to yield Bjorken's scaling law. Particularly, the threshold behavior is predicted as $\nu W_2 \sim (\omega - 1)^3$, corresponding to the decrease of the elastic form factor $G(t) \sim (-t)^{-2}\log(-t)$ at large momentum transfer. This is just what Drell and Yan conjectured apart from the logarithmic term. On the other hand, the asymptotic behavior is given by $W_1 \sim \omega^{\alpha(0)}$ and $\nu W_2 \sim \omega^{\alpha(0)-1}$. (auth)

17442 RESONANCES AND DEEP INELASTIC ELECTRON–NUCLEON SCATTERING. Pavkovic, Marko I. (Tel-Aviv Univ., Israel). Ann. Phys. (N. Y.); 62: 1-43(Jan 1971).

A model for the inelastic electron–nucleon scattering is considered, based on the formation and subsequent decay of an infinite number of isobar resonances with unbounded mass and spin. The resonances are described by the infinite component wave equations. Special attention is given to the deep inelastic electron–nucleon scattering and the conditions are stated for the existence of Bjorken limits, $F_1(w) = \lim_{\nu\to\infty} W_1(q^2,\nu)$, $w = 2M_N\nu/-q^2$ fixed, and $F_2(w) = \lim_{\nu\to\infty} \nu W_2(q^2,\nu)$, w fixed. Two specific models, based on the Nambu–Fronsdal and Abers–Grodsky–Norton wave equations, respectively, are examined, and it is found that the first model gives vanishing $F_1(w)$ and $F_2(w)$ functions, while in the second model, $F_1(w)$ and $F_2(w)$ diverge. These two opposite extremes authorize one to speculate upon the feasibility of an infinite multiplet model possessing finite Bjorken limits for the functions $F_1(w)$ and $F_2(w)$. (auth)

17443 SPECTRAL INTENSITY, ANGULAR DISTRIBUTION, AND POLARISATION OF SYNCHROTRON RADIATION FROM A MONOENERGETIC ELECTRON. Lang, James (Univ. of Glasgow). Comput. Phys. Commun.; 1: 440-4(Dec 1970).

The program SYNCHROTRON RADIATION gives the intensity distribution of radiation from a monoenergetic electron moving in a circular orbit in a synchrotron. The results can be used to find the intensity distributions from a synchrotron. The program is written in FORTRAN for the ICL KDF9 computer. The structure of the program, method of calculation of the spectral intensities, polarization and angular distributions, description of test run are discussed. (J.F.P.)

17444 BOSON ELECTROMAGNETIC VERTEX FUNCTION IN THE VENEZIANO MODEL. Namiki, Mikio; Ohba, Ichiro (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 44: 1312-16 (Nov 1970).

A possible way of deriving the electromagnetic vertex function of boson is proposed within the operator formalism of the Veneziano model, by introducing an indefinite number of spurions. It is shown that the method leads us to the modification of trajectory intercept as assumed in a previous work, and the boson electromagnetic form factor of the dipole type. The introduction of electromagnetic field in the present method may be accepted on the basis of the conventional field theory. (auth)

17445 QUARK-MODEL PREDICTIONS FOR FORM FACTORS IN INELASTIC ELECTRON SCATTERING. Thornber, N. S. (Newark Coll. of Engineering, N. J.). Phys. Rev., D; 3: 787-9 (1 Feb 1971).

The three form factors associated with inelastic electron scattering are discussed in the framework of the symmetric quark model. Predictions are presented for each of ten nucleon resonances; a comparison with the available coincidence data is made. (auth)

17446 K^+ CHARGE FORM FACTOR AND THE CHOU–YANG MODEL. Mickens, R. E. (Massachusetts Inst. of Tech., Cambridge); Rush, J. E. Jr. Contract AT(30-1)-2098. Phys. Rev., D; 3: 784-5(1 Feb 1971).

The Chou–Yang model is used to calculate the K^+ charge form factor. (auth)

17447 RECOIL PROTONS FROM WIDE-ANGLE BREMSSTRAHLUNG. Allton, E. A. (Laboratoire de l'Accelerateur Lineaire, Orsay, France. Daresbury Nuclear Physics Lab., Eng.); Erickson, E. F. Phys. Rev., D; 3: 762-9(1 Feb 1971).

Inelastic electron–proton scattering may be studied experimentally by momentum analyzing and detecting the final proton, in which case it becomes necessary to consider the contribution made by wide-angle bremsstrahlung. The Bethe–Heitler contribution to the cross section for this process is calculated, differential in proton momentum and solid angle, and integrated over the phase space available to the unobserved final electron and photon. The result may be applied to muon–proton bremsstrahlung as well. If the electron rest mass is neglected where possible, the final formula takes a simple form as the sum of two terms. Of these, the domi-

nant term containing a logarithm is proportional to the elastic scattering cross section, while the minor nonlogarithmic term can usually be neglected. The resulting formula is similar to that for the concomitant process in which the incoming electron radiates a photon in a physical radiator upstream and then scatters elastically from a proton, which in turn recoils into the detector. The factoring of the elastic scattering cross section occurs also when the final electron rather than the recoil proton is observed, a result which depends upon the so-called peaking approximation. In the present calculation the factoring of the leading term is exact for relativistic electrons. (auth)

17448 NOTE ON A POSSIBLE AVOIDANCE OF THE FIXED POLE AT J = 0 IN THE PRESENCE OF THE IONIZATION POINT. Shibasaki, Ichiro; Watanabe, Tsunetoshi (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 44: 1414-16(Nov 1970).

The existence of a fixed pole at J = 0 in Compton scattering was suggested from a recent analysis of photon–proton total cross sections by Damashek and Gilman. Speculations are made concerning the possibility of avoiding the fixed pole by taking into account new phenomena above the ionization point. (L.B.S.)

17449 BROKEN SCALE INVARIANCE AND KINEMATIC MOMENTS OF ELECTROPRODUCTION CROSS SECTIONS. Budny, Robert (Univ. of Maryland, College Park). Phys. Rev., D; 3: 744-6(1 Feb 1971).

Expressions for high-energy limits of electroproduction cross sections weighted by $-q^2\omega$, $\omega\nu^{-2}$, and q^4 at constant s, θ, and ν, respectively, are derived from sum rules in the broken-scale-invariance scheme of Ciccariello, Gatto, Sartori, and Tonin. (auth)

17450 ANNIHILATION OF ELECTRON–POSITRON PAIRS INTO MESONS. Kramer, G. (Univ., Hamburg); Uretsky, J. L.; Walsh, T. F. Phys. Rev., D; 3: 719-23(1 Feb 1971).

The cross section for $e^+e^- \rightarrow$ mesons is estimated using (i) ρ dominance of the electromagnetic current, (ii) known couplings of resonances to states involving the on-shell ρ meson, and (iii) the assumption, for the purpose of obtaining numerical estimates, that the meson couplings vary slowly with virtual ρ mass. It is concluded that the cross section at 2-GeV total energy could be comparable to the $e^+e^- \rightarrow \mu^+\mu^-$ cross section. An attempt is also made to estimate a cross section from the statistical model of Bjorken and Brodsky. (auth)

17451 QUANTUM ELECTRODYNAMICS OF SPINLESS PARTICLES BETWEEN CONDUCTING PLATES. Barton, G. (Univ. of Sussex, Brighton, Eng.). Proc. Roy. Soc. (London), Ser. A; 320: 251-75(15 Dec 1970).

The energy of any system containing charged particles arises partly from its coupling to the quantized electromagnetic field; it changes on inserting the system between conducting plates, because these alter the normal modes of the field relative to free space. Such energy shifts were calculated to an order e^2 for a free electron and for a hydrogen atom, neglecting spin, but allowing in full for electrostatic and retardation corrections as well as for changes in the Lamb shift proper. The potential between a particle and a single plate follows as a limiting case. The distinction between classical and quantum effects is detailed. For free electrons there is a quantum shift of order $e^2\hbar/mcL^2$, and classical corrections of order e^2v^2/c^2L (L = plate separation). For atoms, for $L \ll \Lambda$ = (typical absorption wavelength), the shift is of order e^2a^2/L^3 (a = Bohr radius). For $L \gg \Lambda$, the ground state shift is of order $\hbar cL^{-4} \times$ atomic polarizability, and excited state shifts are of order $e^2\hbar^2/a^2m^2c^2L = (e^2/\hbar c)^2e^2/L$. The latter dominate the effect on all electric dipole (optical-frequency) lines. Comparison with experiments to date must await extension of the theory to particles with spin. (auth) (UK)

Weak

Refer also to abstract 17540.

17452 (AD–713108) LONG-RANGE CORRECTIONS TO THE COULOMB POTENTIAL AND THEIR IMPLICATIONS ABOUT WEAK INTERACTIONS. Chang, Shau-Jin; Rajaraman, R. (Institute for Advanced Study, Princeton, N. J.). Feb 1969. 15p. NTIS.

Calculated corrections to the photon propagator due to the creation of virtual neutrino pairs are presented. These are shown to result in long range ($1/r^3$ and $1/r^5$ type) corrections to the Coulomb potential. It is shown that these corrections are of significance because upper limits on their strengths lead to upper limits on lambda, the weak interaction cutoff, and on possible nonconservation of the mu-quantum number. A discussion is given of these upper limits as obtained from the present accuracy of Lamb shift measurements. (auth)

17453 (COO–1573-73) THE INTERMEDIATE BOSON. I. TOTAL PRODUCTION CROSS SECTIONS IN HIGH ENERGY NEUTRINO AND MUON EXPERIMENTS. Brown, R. W. (Brookhaven National Lab., Upton, N. Y.); Smith, J. (State Univ. of New York, Stony Brook, Inst. for Theoretical Physics). [1970]. Contract AT(11-1)-1573. 68p. (BNL–15170). Dep. NTIS.

The theoretical total cross sections are presented for W-boson production in the reactions $\nu + Z \rightarrow Z + W + \mu$ and $\mu + Z \rightarrow Z + W + \nu$ for a variety of Z. The emphasis is on the energies and corresponding W-boson masses pertinent to N.A.L. The effects of the W's anomalous magnetic moment, the nucleon Fermi motion, the Pauli exclusion principle, inelastic channels (in particular, deep inelastic ones), and the problem of incoherent versus coherent production are all discussed. Also a critique of some recent high energy compilations is given. (auth)

17454 (UR–875-331) THEORY OF SECOND CLASS CURRENTS IN WEAK INTERACTIONS. Okubo, Susumu (Rochester Univ., N. Y. Dept. of Physics and Astronomy). [1970]. Contract AT(30-1)-875. 23p. (CONF-710106–1). Dep. NTIS.

From Coral Gables Conference, Coral Gables, Fla.

A simple way of introducing the second-class currents has been suggested by naturally incorporating tensor density in the theory. A possible explanation for large ξ and λ_+ parameters in K_{l3} decays is also proposed. (auth)

17455 SEMILEPTONIC WEAK PROCESSES AND CURRENT COMMUTATORS. Wolsky, Alan Martin. Philadelphia; Univ. of Pennsylvania (1970). 114p. University Microfilms Order No. 70-25,753.

Thesis.

An identity was established which relates the rate of a semileptonic process to the commutator of hadron weak currents. The identity allows a comparison of the predictions of quark algebra and field algebra in a variety of circumstances. This was illustrated by indicating how it may be used in the study of the reactions $K^+ \rightarrow \pi^0 + e^+ + \nu_e$, $n \rightarrow p + e^- + \bar{\nu}_e$ and $\mu^-p \rightarrow n + \nu_\mu$. The last case was studied in detail. It was found that both the quark algebra and field algebra were incompatible with the calculations. (Diss. Abstr. Int., B)

17456 CURRENT ALGEBRA AND WEAK FORM FACTORS. Kawasaki, Zenshiro. Cleveland; Case Western Reserve Univ. (1969). 87p. University Microfilms Order No. 70-25,971.

Thesis.

The momentum dependence of the weak form factors of baryons and mesons is studied. First it is shown how the various weak form factors can be written in terms of strong vertex form factors, which are matrix elements of source currents. For the structure of the latter models are taken reflecting the present knowledge of the vertices. Smoothness assumptions are imposed on the strong vertex form factors. It is shown that this assumption leads to structure for the $\rho\pi\pi$ and $K^*K\pi(\kappa K\pi)$ vertices similar to the Schnitzer–Weinberg method, although the extrapolation procedure a priori is quite different. In the course of the determination of the vertices, generalized Callan–Treiman relations for π_{l3} and K_{l3} are derived. Also the relative strength of the SU(3) breaking interaction to that of chiral symmetry breaking is determined. The existence of the κ-meson is assumed and it is identified with the recently reported $K\pi$ s-wave resonance around 1.1 GeV. The proposed axial-vector form factors of the nucleons are applied to the ρ-production process using the one-pion-exchange model. In summary, this dissertation is an attempt to determine weak form factors of meson and baryons in terms of relevant strong vertices, or vice versa. (Diss. Abstr. Int., B)

17457 A MODEL, BASED UPON CVC AND PCAC, FOR THE NEUTRINO PRODUCTION OF PIONS NEAR THE N*(1236) RESONANCE. Roehner, B.; Kessler, P. (College de France, Paris). Lett. Nuovo Cim.; 1: 45-8(9 Jan 1971).

In the model described the Feynman diagrams (N* term plus Born terms) are summed. The graphs considered are the same as those of a previous model, but there are significant differences in the couplings used, mainly for the axial part. For both the Born terms and the resonant terms the vector and axial parts and vector-axial interference are calculated separately and added at the end. For the vector current CVC together with a previous model were used, while for the axial current one-pion exchange and PCAC were used. This model was used to analyze the interaction $\nu + p \rightarrow \mu^- + \pi^+ + p$, and the results are shown graphically. The detailed analysis shows that the resonant term dominates over the Born terms, the axial part appears to dominate in the resonant term, and the vector part seems to be predominant in the Born terms. Both in the resonant term and in the Born terms the axial part shows a sharp peak at low transfers (Adler's effect) and then decreases rapidly with increasing transfer. (J.F.P.)

XUM

17458 FIT OF THE PARAMETERS FOR CABIBBO'S THEORY. Ebenhoeh, H.; Eisele, F.; Filthuth, H.; (and others) (Univ., Heidelberg). Z. Phys.; 241: 473-9(1971).

All experimental data on leptonic decays of baryons available after the Kiev Conference on high energy physics (Sept. 1970) are used to fit the parameters of the Cabibbo theory. Especially new results on Σ^- and Λ leptonic decays and the values of the Σ^+ lifetime are included. The data are consistent with the one angle Cabibbo theory. The results for the three parameters are: $\theta = 0.239 \pm 0.005$, $g_1^F = 0.451 \pm 0.019$, and $g_1^D = 0.777 \pm 0.021$. (auth)

17459 NUCLEON ENERGY CORRELATIONS IN THE ANTI-NEUTRINO DISINTEGRATION OF THE DEUTERON. Frahm, Charles P. (Argonne National Lab., Ill. Illinois State Univ., Normal). Phys. Rev., D; 3: 663-70(1 Feb 1971).

The correlation in energy between the outgoing nucleons in the process $\bar{\nu} + d \rightarrow n + p + \bar{\nu}$ is calculated on the basis of two weak-leptonic-neutral-current models. The results are presented in the form of several graphs. A novel approach to considerations of phase space in the laboratory frame is presented for two-to-three-body processes. (auth)

17460 SELECTION RULE IN THE WEAK INTERACTION. Noda, Hujio (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 44: 1418-20(Nov 1970).

The quantum number which characterizes the weak interaction and the selection rules in the weak interaction phenomena are discussed. The selections rules are applied to the S- and P-wave decays of nonleptonic hyperon decays and the D- and P-wave decays of Ω^-. (L.B.S.)

17461 REMARKS ON THE QUARK MODEL FOR NONLEPTONIC HYPERON DECAYS. II. Toda, Azuma (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 44: 1420-2(Nov 1970).

It is investigated whether a quark model with vector-meson exchange is consistent with the three properties of nonleptonic hyperon decays, i.e., (i) $|\Delta I| = \frac{1}{2}$, (ii) $S(\Sigma_+^+) = 0$ and $P(\Sigma^-) = 0$, and (iii) the Lee–Sugawara relation $\Lambda_- + 2\Xi^- = \sqrt{3}\,\Sigma_+^+$. (L.B.S.)

17462 PRIMARY VECTOR AND AXIAL-VECTOR INTERACTION MODEL AND K_{l4} DECAYS. Suzuki, Tsuneo (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 44: 1412-14(Nov 1970).

A model is discussed in which the primary interactions of strong, electromagnetic, and weak interactions are respectively direct couplings of the vector and axial-vector fields to hadrons, photons, and weak currents. The model is applied to the calculation of K_{l4}^+ decay rates and vector and axial-vector form factors. (L.B.S.)

17463 CURRENT ALGEBRA AND THE WEAK RADIATIVE DECAYS OF HYPERONS. Ram Mohan, L. R. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. Phys. Rev., D; 3: 785-6(1 Feb 1971).

The recently reported measurement of the asymmetry parameter in the weak radiative decay $\Sigma^+ \rightarrow p\gamma$ suggests that the parity violating amplitude in the decay may be large. Here it is shown that no known theories can account for this result. (auth)

17464 GENERAL LOCAL INTERACTIONS AND TESTS OF V–A THEORY IN NEUTRINO SCATTERING PROCESSES. Cheng, T. P. (Inst. for Advanced Study, Princeton, N. J.); Tung, Wu-ki. Contract AT(11-1)-264. Phys. Rev., D; 3: 733-44(1 Feb 1971).

Neutrino scattering processes are studied in the framework of general local current–current interaction. The scattering amplitudes for such processes are expressed in a simple factorized form in terms of helicity form factors for the current vertex functions. These expressions explicitly display the full kinematic content of the local current–current interaction and are used as the basis for a systematic study of possible ways to test the V–A structure of the weak current in high-energy neutrino scattering processes. A direct test in an "inclusive experiment" consists of measuring the outgoing lepton polarization. Alternative tests from angular and spin correlations are possible only in "exclusive experiments." Several examples of this latter type of experiment are given: (i) pure lepton scattering processes, (ii) neutrino scattering off spin-zero (nuclei) targets, (iii) quasi-elastic scattering off polarized-nucleon targets, (iv) quasi-elastic hyperon production (decay asymmetry), and (v) single-pion production in the N^* region. (auth)

Strong (General)

Refer also to abstract 17558.

17465 (COO-264-568) THEORETICAL RESEARCH IN ELEMENTARY PARTICLE PHYSICS. Technical Progress Report. (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies). [30 Dec 1970]. Contract AT(11-1)-264. 19p. Dep. NTIS.

The theoretical research carried out in high-energy physics covers the Veneziano model, dispersion theory, current algebra, duality, scale invariance, Regge pole theory, diffraction scattering, and weak and electromagnetic processes. A list of publications is included. (J.F.P.)

17466 (COO-264-570) THREE COMPONENTS OF D-SPIN. Freund, Peter G. O. (Chicago Univ., Ill.). Jan 1971. Contract AT(11-1)-264. 29p. (EFI-71-1). Dep. NTIS.

The concept of D-spin, previously introduced to account for the selection rules for exotic hadron couplings, is further investigated. The three components of D-spin are identified. D_3 turns out to be a simple topological characteristic of the way a hadron couples at a vertex. D_3 is conserved at hadronic vertices. In hadronic N-point functions an "effective D_3" is conserved. It is shown that in the presence of three species of quarks (β,N,λ) there are three D-spins. An application of the D-spin formalism to diffractive exotic hadron production is presented. (auth)

17467 TOPICS IN STRONG INTERACTIONS: I. CURRENTS AS DYNAMICAL VARIABLES. II. THEORY OF LARGE MOMENTUM-TRANSFER HADRON PRODUCTION. Chen, Min-shih. New Haven; Yale Univ. (1970). 132p. University Microfilms Order No. 70-25,248.

Thesis.

Selected topics in strong interactions are discussed. The problems in constructing a model theory with currents as dynamical variables are studied. The discussion is essentially concentrated on the properties of the Sugawara model. A canonical representation of the general SU(n) Sugawara model is found. The nature and breaking of an extra symmetry associated with the massive Yang–Mills theory of vector and axial-vector mesons and the SU(n) ⊗ SU(n) Sugawara model is studied and an alternative model theory of currents, closely related to the nonlinear Lagrangian models, without this extra symmetry is constructed. The singular nature of the energy-momentum tensor involving the products of currents at the same space-time point is discussed and modified, and a set of spectral sum rules is derived. A model, based on the Wu–Yang idea, is developed to provide a framework for analyzing the asymptotic behavior of the differential cross section for the production process hadron + hadron → wide angle hadron + anything when the momentum transfer to the observed final state hadron is large. Two different production mechanisms, a peripheral and a central process, are found to interplay and compete in the high-energy, wide-angle region. Each of these mechanisms leads to a characteristic differential cross section. The measured pion and proton production cross sections in inelastic proton–proton scattering are found to be dominated by the peripheral and central processes respectively. In addition, predictions for as yet unexplored kinematical regions for those processes and for some other processes are made. (Diss. Abstr. Int., B)

17468 COMMENTS ON INTERNAL SYMMETRIES IN DUAL MODELS. Mestres, L. Gonzalez (Univ., Barcelona. Laboratoire de Physique Theorique et Particules Elementaires, Orsay, France). Lett. Nuovo Cim.; 4: 1207-12(19 Dec 1970).

A proof is presented on the uniqueness of the Chan–Paton factor for the meson Born term in the framework of dual-resonance models, using only SU(3) and absence of exotics. The proof is first made for N traceless octets. The meson spectra is then analyzed. It is further shown that the Chan–Paton factor must hold also for N external nonets as a consequence of the bootstrap condition. (L.B.S.)

17469 DILATATIONS AND A "MODEL" FIELD THEORY WITH INDEFINITE METRIC. Eberle, E. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Lett. Nuovo Cim.; 1: 71-3(9 Jan 1971).

A model field theory with indefinite metric is derived, and dilatations are used to transform a nonphysical situation into the physical situation. Thus there is a possibility of performing calculations in such a model theory and then by dilatations to arrive at the physical situation where all the observational requirements are recovered. (J.F.P.)

17470 MULTI-REGGE MODEL OF PRODUCTION PROCESSES AT HIGH ENERGY. Chan, Hong-mo (CERN, Geneva). pp 1-44 of Topics in Theoretical Physics. /Riska, Dan Olof (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The phenomenological aspects of the multi-Regge model are discussed. In this way hadron multiple production in strong interactions is summarized. The formulation of the multi-Regge model, application to two- and three-body production processes, emerging particle clusters with low effective masses, resonance production, and the phase of the amplitude are covered. (J.F.P.)

17471 CROSS SECTIONS WHICH WILL BE LARGE AT VERY HIGH ENERGIES. Kane, Gordon (Univ. of Michigan, Ann Arbor).

pp 87-152 of Topics in Theoretical Physics. /Riska, Dan Olof (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The cross sections of very high energy hadron strong interactions are discussed omitting the very complicated elastic cross sections. The topics considered include kinematics and phase space, diffraction dissociation processes, peripheral inelastic processes, and high-energy contributions from Regge cuts. (J.F.P.)

17472 MULTIPLE SCATTERING CORRECTIONS TO REGGE POLE EXCHANGE. Frautschi, Steven (California Inst. of Tech., Pasadena). pp 153-83 of Topics in Theoretical Physics. /Riska, Dan Olof (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The discussion of multiple scattering corrections to Regge pole exchange in strong interactions covers Regge cuts, multiple scattering, and the multiple scattering Regge model. Included in the discussion of the Regge model are t dependence, the amplitude, number of parameters, secondary trajectories, crossover, shrinking, relation with absorption models, and conspiracy. (J.F.P.)

17473 INTERACTIONS OF NUCLEONS AT VERY HIGH ENERGIES. Miesowicz, Marian (Instytut Techniki Jadrowej AGH, Krakow). Zesz. Nauk. Akad. Gorn.-Hutn. Krakow., Rozpr.; 208: No. 2, 53-64(1969). (In Polish).

A fireball model with possible isobar excitation was analyzed. An anisotropy of particles in cms produced in the pionization process is described, and the resulting limitation of the isobar mass was discussed. (auth)

17474 QUARK COUNTING ADDITIVITY SUM RULES. Matsuda, Masanori (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 44: 1300-6(Nov 1970).

It is suggested that the inelastic amplitudes which generate the imaginary parts of the elastic scattering amplitudes have an additivity property, instead of the quark counting additivity assumed for the elastic scattering amplitudes. It is shown that the resulting sum rules are consistent with the experimental data. The present approach gives consistent results on the observed correlation between the total cross sections and the slopes of elastic cross sections. (auth)

17475 DEFORMABLE SPHERE MODEL OF HADRONS. Hara, Osamu; Goto, Tetsuo (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 44: 1383-1411(Nov 1970).

Deformable sphere model of hadrons in which hadrons are assumed to correspond to the excited states of a deformable sphere is developed and is applied to the analysis of the level structure of the hadrons. It is shown that such a model leads to a unified understanding of almost all known levels of both baryons and mesons. (auth)

17476 QUANTUM FIELD THEORY AND DIFFRACTION SCATTERING OF MESONS AND BARYONS. Budnev, V. M.; Ginzburg, I. F.; Serbo, V. G. (Inst. of Mathematics, Novosibirsk, USSR). Teor. Mat. Fiz.; 6: 55-70(Jan 1971). (In Russian).

The summation of all logarithmical terms of all graphs in mesodynamics for the hadron scattering at high energies and small angles leads to a new representation for scattering amplitude. This representation contains the moving poles and fixed singularities in j-plane. If the renormalizations of coupling constants and wave functions are finite then these fixed singularities are square-root branch points. This representation is suitable as the basis of a well-grounded phenomenological description of high-energy scattering and as the basis of the study of Regge trajectories properties. For example, one has the conspiring trajectories π and π_c and residues of amplitudes of meson–baryon and baryon–baryon scattering are proportional to $j = \alpha(t)$, i.e., they lead to the dips in the angular distributions at $\alpha(t) = 0$. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 17382.

17477 (JINR-E2-5249) ON CHIRAL $SU_2 \times SU_2$ DYNAMICS FOR A_1, ρ AND π MESONS. Ogievetsky, V. I.; Zupnik, B. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 19p. Dep. NTIS (U. S. Sales Only).

It is remarked that the conventional effective Lagrangian with ρ and A_1 mesons contains 3- and 4-linear derivative couplings. So one should add independently all terms with 3 and 4 derivatives, then the theory should contain a number of arbitrary parameters. A new Lagrangian is suggested for the $A_1\rho\pi$ system containing no more than two field derivatives in each term. This model is determined only by four parameters g_ρ, g_A, m_ρ, M_A and gives the smoothest momentum dependence for the contact vertices. The reasonable value $\delta = -1$ is derived for the anomalous magnetic moment of A_1 if the KSFR relation holds, and also the model is applied to $\pi\pi$ scattering and A_1 decay. (auth)

17478 (JINR-E3-4976) E-η MIXING AND SOME RADIATIVE DECAY PROCESSES. Tybor, W.; Zaslavsky, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics) 1970. 11p. Dep. NTIS (U. S. Sales Only).

The consequences of E-η mixing under the assumption that the E(1420) meson takes the ninth place in a pseudoscalar nonet are discussed. The width values of $E \to 2\gamma$, $E \to \rho\gamma$, $E \to \omega\gamma$, etc found in various models are presented. A value $\Gamma(E \to 2\gamma) \sim (200-300)$ keV turns out to be rather large, the decay width $E \to \rho\gamma$ being ~10 MeV. The determination of the decay $E \to 2\gamma$ would prove the pseudoscalarity of the E-meson, the investigation of the E-meson radiative decay width would help to select reasonable models. (auth)

17479 TWO TOPICS IN ELEMENTARY PARTICLE PHYSICS: I. CROSSING AS A GROUP AND ELIMINATION OF EXOTIC CHANNELS. II. REAL PARTS OF MESON–NUCLEON FORWARD SCATTERING AMPLITUDES. Yahil, Amos. Pasadena, Calif.; California Inst. of Tech. (1970). 58p. University Microfilms Order No. 70-24,319.

Thesis.

Crossing transformations constitute a group of permutations under which the scattering amplitude is invariant. Using Mandelstem's analyticity, the amplitude is decomposed into irreducible representations of this group. The usual quantum numbers, such as isospin or SU(3), are "crossing-invariant." Thus no higher symmetry is generated by crossing itself. However, elimination of certain quantum numbers in intermediate states is not crossing-invariant, and higher symmetries have to be introduced to make it possible. The current literature on exchange degeneracy is a manifestation of this statement. To exemplify application of the analysis, it is shown how, starting with SU(3) invariance, one can use crossing and the absence of exotic channels to derive the quark-model picture of the tensor nonet. No detailed dynamical input is used. A dispersion relation calculation of the real parts of forward $\pi^\pm$p and $K^\pm$p scattering amplitudes is carried out under the assumption of constant total cross sections in the Serpukhov energy range. Comparison with existing experimental results as well as predictions for future high-energy experiments are presented and discussed. Electromagnetic effects are found to be too small to account for the expected difference between the π^-p and π^+p total cross sections at higher energies. (Diss. Abstr. Int., B)

17480 VECTOR–VECTOR–PSEUDOSCALAR MESON COUPLING IN A CHIRAL-INVARIANT LAGRANGIAN. Bose, S. K. (Manchester Univ., Eng.); Ndili, F. N. Lett. Nuovo Cim.; 1: 57-60(9 Jan 1971).

The inclusion of VVπ and AAπ type couplings in a chiral-invariant Lagrangian is investigated. It is found that by redefining chiral transformations of scalar fields, it is possible to do so if the transformation parameter is taken to be space–time independent. (J.F.P.)

17481 RELATIVISTIC EXPANSIONS OF SCATTERING AMPLITUDES AND THE REGGE POLE THEORY. Winternitz, Pavel (Joint Inst. for Nuclear Research, Dubna, USSR). pp 265-92 of Topics in Theoretical Physics. /Riska, Dan Olof (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The theory of expanding relativistic amplitudes into series and integrals over the irreducible representations of the group O(3,1) is treated. Only spinless-particle two-body scattering is considered. Double expansions are obtained which are valid for arbitrary masses, and for all values of the Mandelstam variables s and t. Topics discussed include the definition of the scattering amplitude as a function on the hyperboloid $u^2 = 1$ in the relativistic velocity space, the group O(3,1) and its basis functions, the direct and inverse expansion formulas, the relation to little group expansions, and Lorentz amplitudes and Regge poles. Coulomb scattering, elastic scattering at t = 0, and daughter poles, the relation to the Toller expansions, and the crossing transformation are also considered. (J.F.P.)

17482 MASS STRUCTURE OF THE A_2-MESON. Lassila, K. E.; Ruuskanen, P. V.; Beaupre, J. V.; Austin, D. M. (Iowa State Univ., Ames). pp 293-308 of Topics in Theoretical Physics. /Riska, Dan Olof (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

A double-pole model for properties of the mass distributions in the region of the A_2 meson at 1300 GeV is discussed. A detailed examination of the implications of some new data for the double-pole structure of the A_2 is given. It is pointed out that the model predicts that the $K\bar{K}$ mass distribution is considerably narrower than that for the $\pi\rho$ decay mode of the A_2 produced in π + p interactions. The consequences of the double-pole model for the interaction π^- + p → η + n are examined. (J.F.P.)

XUM

17483 CRITICAL REVIEW OF $\pi\pi$ AND $K\pi$ SCATTERING. THEORY AND EXPERIMENT. Kane, G. L. (Univ. of Michigan, Ann Arbor). pp 1-39 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

The review of $\pi + \pi$ and $K + \pi$ scattering covers scattering data from pion production, pion exchange, two models, and $\pi + \pi$ and $K + \pi$ phase shifts. Finally, some predictions and results are surveyed for topics on very forward $\pi N \to \rho N$, $\pi^0\pi^0$ results, and s-wave resonances. (J.F.P.)

17484 PICTURE OF $\rho-\omega$ MIXING. Glashow, S. L. (Harvard Univ., Cambridge, Mass.). pp 135-41 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

A discussion of $\rho-\omega$ mixing in elastic multi-channel scattering in the neighborhood of the ρ mass is presented. Only states with $J^{PC} = 1^{2-}$ are involved, and each of these is regarded as effectively a two-body state. The three hypotheses used are that the T matrix is given by a sum of two simple Breit–Wigner poles with no additional background term, time reversal invariance, and unitarity. Good agreement with experiment is found. (J.F.P.)

17485 MASS DEPENDENT PHENOMENA AND S-CHANNEL HELICITY CONSERVATION IN PHOTOPRODUCTION OF RHO MESONS. Maor, Uri (Univ. of California, Berkeley). pp 165-70 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

A parametrization correlating the s-channel helicity conservation and a variety of mass-dependent phenomena in the reaction $\gamma + \pi \to \rho^0 + \pi$ is suggested. Crossing and t-channel kinematics are used. (J.F.P.)

17486 SPIN PARITY AND PRODUCTION MECHANISM IN THE A_2 REGION. Kruse, U. E. (Univ. of Illinois, Urbana). pp 359-68 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

The 3π states are analyzed in $\pi^- + p \to p + 2\pi^- + \pi^+$ interactions at 5 and 7.5 GeV/c using a previous partial-wave analysis. The spin and parity and polarization for both the upper and lower halves of the A_2 are studied. It is found that the upper and lower parts of the A_2 are both $J^P = 2^+$, and no other allowed spin parities up to spin 2 show any significant structure. The polarization is also the same in both upper and lower A_2. (J.F.P.)

17487 PHYSICS BEHIND SPLIT MESONS. Sutherland, David G. (Univ. of Glasgow). pp 369-93 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

The new features to be expected when two closely overlapping resonances are present, differences in $\pi^+ + p$ and $\pi^- + p$ results on the A_2, a review of the models for explaining the A_2 splitting particularly the new data implications, and some speculations on more general implications of the A_2 splitting are considered. (J.F.P.)

17488 COMMENTARY ON MESON SPECTROSCOPY. Meshkov, Sydney (National Bureau of Standards, Washington, D. C.). pp 535-46 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

The splitting of the A_2 meson is discussed as though there are two resonances with the same decay properties, the same decay ratio for the $\rho\pi$, $\bar{K}K$, and $\eta\pi$ modes, and that they are both $J^{PC} = 2^{2+}$. Meson classification, $SU(6)_W$ decay amplitudes and selection rules for the 405 representation, the split A_2 system, splitting of the K* and f, and SU(3) selection rules are considered. (J.F.P.)

17489 DUAL RESONANCE MODELS WITH RESIDUES HAVING A MAXIMUM FIXED FINITE NUMBER OF MONOMIALS IN ONE MANDELSTAM VARIABLE: LOGARITHMIC POLES. Cremmer, E.; Nuyts, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B26: 151-66 (1971).

It is shown that the equation $A(s,t) = \sum_{n=0}^{\infty}[R_n(t)/s - X_n] = \sum_{n=0}^{\infty}[R_n(s)/t - X_n]$, where $R_n(t) = \sum_{q=\max(0,n-Q)}^{n} r_{nq} t^q$ and Q is finite and arbitrary (finite number of logarithmic poles), implies a logarithmic trajectory $X_n = X_0\lambda^n(\lambda > 1)$. The resulting amplitude A(s,t) can be expressed in terms of one universal function of two variables F(x,y) but unfortunately leads to rather unsatisfactory physical conclusions. (auth)

17490 CROSS-CHANNEL ISOSPIN ANALYSIS OF PERIPHERAL SINGLE-PION PRODUCTION PROCESSES. Koba, Z.; Moellerud, R.; Veje, L. (Univ. of Copenhagen). Nucl. Phys.; B26: 134-40(1971).

A cross-channel isospin analysis of experimental data on peripheral single-pion or single-rho-meson production processes will lead to evaluation of the I = 0 and I = 1 exchange amplitudes, if the $I \geq 2$ exchange is absent. (auth)

17491 UNIQUENESS OF THE PATON–CHAN ISOSPIN FACTOR FOR THE EXCLUSION OF EXOTIC STATES IN DUAL RESONANCE MODELS. Toernqvist, Nils A. (Univ. of Helsinki). Nucl. Phys.; B26: 104-8(1971).

A proof is given for the uniqueness of the Paton–Chan formula for coupling N isospin-one particles in a way in which exotic states are excluded from dual resonance models. (auth)

17492 COULOMB PRODUCTION METHOD FOR STUDYING $\pi\pi$ INTERACTIONS. Jurisic, N. (Univ. of California, Davis); Stodolsky, L. Phys. Rev., D; 3: 724-9(1 Feb 1971).

The production of pion pairs in the Coulomb field by photons and pions is considered as a method which can be used to study the $\pi\pi$ interaction. Simple general formulas are given for the angular correlations of the π pairs, the behavior of the cross section with angle and energy, and the effects of the ρ^0 coherent production background. (auth)

17493 VENEZIANO FORMULA, K_A MESON DECAYS, AND WEINBERG LIMITS OF K_{l4} FORM FACTORS. Biswas, S. N.; Datta, K.; Panchapakesan, N.; Varma, V. S. (Univ. of Delhi). Phys. Rev., D; 3: 729-32(1 Feb 1971).

s- and d-wave ratios of $g_{K_AK\rho}$ and $g_{K_AK\xi}$ couplings were determined using Veneziano representations for $K_A\pi \to K\pi$ amplitudes. The results are in agreement with those obtained by the hard-meson techniques of current algebra. Assuming that the axial-vector current is dominated by K_A- and K-meson poles only, the K_{l4} form factors are obtained from $K\pi \to K_A\pi$ and $K\pi \to K\pi$ scattering amplitudes when the K_A and one of the K mesons are taken off shell. Current-algebra constraints due to Weinberg, when both pions are soft, are then used to fix the arbitrary parameters of the theory. It is found that consistency of the results with current-algebra predictions requires the presence of nonleading Veneziano amplitudes. (auth)

17494 STUDIES OF PROPOSED STRUCTURE IN THE ρ-MESON MASS. Zacrep, D. B.; Lassila, K. E.; Kernan, W. J. (Ames Lab., Iowa). Phys. Rev., D; 3: 671-6(1 Feb 1971).

Monte Carlo techniques were used to study the dependence of the "observed" ρ-meson mass distribution on the width of the experimental resolution function and on the theoretical shape which the ρ might be expected to assume with infinitely good resolution. By using presently available mass resolutions, it is found that structure similar to that of the A_2 meson would already have been observed if the ρ were a dipole resonance, as proposed by Kreps and Moffat. Some other possible mass shapes suggested in part by the $\rho + \rho'$ model which could easily have been missed are considered. Inferences relevant to the A_2 meson are also drawn. (auth)

17495 DUALITY AND THE REGGE-POLE EIKONAL SCHEME. Barnett, R. Michael (Univ. of Chicago. Argonne National Lab., Ill.). Phys. Rev., D; 3: 681-9(1 Feb 1971).

The Regge-pole eikonal scheme is used to generate the partial and total cross sections and Argand diagrams in $\pi^+\pi^-$ and πp scattering at intermediate and low energies. The correspondence between the calculated partial-wave results and the observed s-channel resonances is closer than with the direct use of Regge poles, but the total cross sections at lower energies completely lack the experimentally observed structure. (auth)

17496 PATTERNS IN DIRECT-CHANNEL HELICITY AMPLITUDES CAUSED BY CROSSED-CHANNEL EXCHANGES. Jones, Lorella M.; Ravenhall, D. G. (Univ. of Illinois, Urbana). Phys. Rev., D; 3: 696-704(1 Feb 1971).

A set of patterns for Reggeon exchanges in elastic scattering is discussed. Each pattern corresponds to a particular set of t-channel quantum numbers, and allows only certain s-channel helicity amplitudes $f_{cd;ab}$ to be present to order s^α. These dominant amplitudes are those such that $|c \pm a| = n$, and $|d \pm b| = m$, where n and m are integers, and the pattern is labeled by n,m and the choice of + or – in each case. Any Regge residue may be constructed as a linear combination of the basic "–" patterns; any Regge residue which vanishes sufficiently rapidly at t = 0 may be constructed as a linear combination of the basic "+" patterns. Correct behavior for both s- and t-channel amplitudes at t = 0 and t-channel thresholds is ensured by the formalism. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 17446 and 17542.

17497 (JINR-E2-5216) THEORETICAL MODEL-INDEPENDENT DETERMINATION OF THE REAL PARTS OF THE K^-p FORWARD SCATTERING AMPLITUDES. Dumbrais, O. V.; Dumbrais, T. Yu.; Queen, N. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 33p. Dep. NTIS (U. S. Sales Only).

A new method of analyzing the experimental data on kaon-proton scattering is used to obtain an accurate determination of the real parts of the forward scattering amplitudes at moderate energies. The method exploits the known analyticity properties of the scattering amplitude and experimental data in a limited energy range. However, unlike conventional dispersion relation calculations, it requires no assumptions about the residues of the hyperon pole terms and the amplitudes in the unphysical and asymptotic regions. A parameter describing the unknown asymptotic behavior of the difference of the K^-p and K^+p total cross sections is determined. Its value favors a zero asymptotic limit for this difference but requires a slower approach to zero than that predicted by conventional Regge pole models which satisfy the Pomeranchuk theorem. The method can be used in principle to analytically continue the scattering amplitude from the physical region to the Λ pole. However, a sufficiently accurate model-independent determination of the KNΛ coupling constant cannot be obtained in this way using the experimental data which exist at the present time. (auth)

17498 (JINR-E2-5217) STRAIGHT-LINE PARTICLE PATHS APPROXIMATION FOR DESCRIPTION OF HIGH-ENERGY HADRON SCATTERING IN QUANTUM FIELD THEORY. Barbashov, B. M.; Kuleshov, S. P.; Matveev, V. A.; Pervushin, V. N.; Sissakian, A. N.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 24p. Dep. NTIS (U. S. Sales Only).

The problem of an asymptotic behavior of high-energy elastic and inelastic process amplitudes is studied by means of the functional integration methods in quantum field theory. The straight-line particle path approximation permitting effective calculation of available functional integrals is formulated. The closed relativistic invariant expression for both elastic and inelastic scattering amplitudes are obtained in the scalar nucleon-vector meson interaction model. (auth)

17499 (JINR-E2-5509) TOTAL SUMMATION OF PERTURBATION SERIES AT HIGH ENERGIES AND DIFFRACTION SCATTERING. Budnev, V. M.; Efremov, A. V.; Ginzburg, I. F.; Serbo, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 28p. (CONF-700806-56). Dep. NTIS (U. S. Sales Only).

From 15th International Conference on High Energy Physics, Kiev, USSR.

It is shown, that the introduction of the spin leads to an essential change in the structure of the j-plane and in the behavior of the amplitudes off the mass shell. The reason for this is a singular character of the interaction at small distance. High-energy summation of the all, logarithmic terms of all the diagrams in pseudoscalar mesodynamics gives a new representation for the scattering amplitudes. In addition to the moving Regge poles, there appears a standing singularity. In the case of finite renormalization of the coupling constant and the wave function it is a square root branch point the position of which is determined by the bare coupling constant. The amplitudes do not vanish with the growth of external mass ($M^2 \gtrsim S \to \infty$). This representation can serve as a basis for phenomenological description and the study of the properties of the Regge trajectories. For example, there are the conspiration of π and π_c-trajectories and the proportionality of the residue of the Regge trajectories in meson-baryon and baryon-baryon scattering to their position $j = \alpha(t)$. This leads to the dips in the angular distributions when $\alpha(t) = 0$. (auth)

17500 EFFECT OF PHASE-SHIFT AMBIGUITIES ON FINITE-ENERGY SUM RULES. Bowcock, J. E.; Ng, P. H. (Univ. of Birmingham, Eng.). Lett. Nuovo Cim.; 1: 49-52(9 Jan 1971).

Phase shift ambiguity effects on the use of finite-energy sum rules for $\pi + N$ amplitudes are investigated. Finite-energy sum rules with a moment factor are considered. It is concluded that in using the finite-energy sum rules quantitatively for obtaining values of Regge parameters, the lack of uniqueness of the amplitude should be taken into account and the corresponding uncertainty in the Regge parameters evaluated. (J.F.P.)

17501 UNDERSTANDING DIFFRACTIVE PROCESSES. Goldhaber, Alfred S. (State Univ. of New York, Stony Brook); Lubatti, H. J. pp 303-9 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

A review of diffractive processes in $\pi + p \to 3\pi + p$, $K + p \to K + 2\pi + p$ and $p + p \to 2p + 2\pi$ interactions is given. The Deck model is mentioned, and coherent production is discussed for the three reactions with the proton replaced by a nucleus which recoils intact. The results argue against the most naive kinematic interpretation of diffractively produced mass enhancements. (J.F.P.)

17502 STATIC BOOTSTRAP MODELS AND STRONG COUPLING THEORY. Noga, Milan T. (Univ. of Helsinki). pp 45-86 of Topics in Theoretical Physics. /Riska, Dan Olof (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

With the assumption that the bootstrap represents some profound principle of strong interactions, the bootstrap dynamics is reduced to a game with Lie algebras of certain symmetry groups within the Chew-Low static model. The Chew-Low equation is completed by the self-consistency condition proposed previously to obtain the static bootstrap model. It is found that the self-consistency condition generates immediately a certain Lie algebra which defines the strong coupling group. Having this bootstrap algebra of the static model, it is found that the unitary representations are furnished with an infinite number of baryon states, the coupling constants of which are mutually correlated, allowing the prediction of various decay widths of baryon resonances. Mass formulas for baryons following from the bootstrap model are discussed when the limit of meson-baryon coupling constants, tending to infinity in such a way that their ratios are finite, is considered. (J.F.P.)

17503 REGGE BOOTSTRAPS. Fairlie, David (Univ. of Durham, Eng.). pp 185-212 of Topics in Theoretical Physics. /Riska, Dan Olof (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

Some developments in the relations between Regge trajectories and low-energy resonances in the framework of conventional dynamics are reviewed. It is noted that the finite-energy sum rules were principally used for these relations. The derivatives of the finite-energy sum rules and the saturation of these sum rules by infinite towers of resonances are considered. (J.F.P.)

17504 THEORETICAL EVIDENCE FOR I = 0 Z*'s. Aaron, R. (Los Alamos Scientific Lab., N. Mex. Northeastern Univ., Boston); Amado, R. D.; Silbar, R. R. Phys. Rev. Lett.; 26: 407-10(15 Feb 1971).

Strong theoretical evidence for the existence of highly inelastic I = 0 K-N (Z*) resonances in the $S_{\frac{1}{2}}$ and $D_{\frac{3}{2}}$ states at cm energies near 1830 MeV with widths of about 100 MeV is presented. (auth)

17505 LINE-REVERSAL SYMMETRY BREAKING AND THE QUARK MODEL. Fialkowski, K. (Jagellonian Univ., Krakow). Acta Phys. Pol.; B1: 375-82(Oct-Dec 1970).

The recently observed violation of exchange degeneracy rules for charge- and strangeness-exchange meson-baryon scattering is discussed in the framework of the quark model. It is shown that one can qualitatively describe the effect using the model in which q-q and $q-\bar{q}$ amplitudes have Regge form with exact exchange degeneracy and all observed deviations are caused by three-quark (q-qq) scattering. (auth)

17506 RIGOROUS BOUNDS ON AVERAGED CROSS SECTIONS FOR THE SCATTERING OF PIONS ON ANY TARGET. Common, A. K. (CERN, Geneva); Yndurain, F. J. Nucl. Phys.; B26: 167-94(1971).

The analysis of previous work is generalized, showing that bounds valid at all energies and without unknown constants can be obtained for pion scattering on nucleons or almost any other target. Asymptotically these bounds correspond to the usual Froissart bounds. The above bounds were previously derived in terms of the partial-wave amplitudes in the t-channel but it is shown that they may also be obtained from direct channel quantities. Numerical results for the scattering of pions on nucleons and helium are presented and indicate that the bounds are reasonably tight at intermediate energies. The bounds even allow one to put constraints on the slope of the Pomeranchuk trajectory and suggest that the binding energy of nucleons in nuclei has to be <10 MeV. Finally the method can be reversed to put lower bounds on t-channel partial-waves. (auth)

17507 DOUBLE-REGGE-POLE ANALYSIS OF $\pi^+p \to \pi^+f^0p$ AT 13.1 GeV/c. Gaidos, J. A.; Ezell, C. R.; Lamsa, J. W.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; B26: 109-20(1971).

A double-Regge model consistent with duality is applied to the reaction $\pi^+p \to \pi^+f^0p$ at 13.1 GeV/c. The diffractively produced πf^0 system is well described by two amplitudes involving Pomeranchuk/A_1 and Pomeranchuk/f^0 exchanges. (auth)

XUM

17508 COMPARATIVE EVALUATION OF THEORIES OF πN BACKWARD SCATTERING. Berger, Edmond L.; Fox, Geoffrey C. (Argonne National Lab., Ill.). Nucl. Phys.; B26: 1-70(1971).

Results of a systematic, comprehensive study of all existing models for high-energy πN backward scattering are reported. Regge-pole models as well as formalisms with Regge cuts are examined. Among the latter, both weak (Argonne) and strong (Michigan) absorption prescriptions are studied. Also several versions of Carlitz–Kislinger and Bardakçi–Halpern pole-cut models are proposed and investigated. Complete fits to all available data in terms of each of these models are presented. It is found that qualitative features of present data are represented adequately by all models. Nevertheless, distinctive properties of the models are identified and it is argued that these are not tested by current data. It is shown that there are substantial differences between predictions of the models. Indeed, both at present accelerator energies and higher, decisive measurements may be made of $d\sigma/du$, P, and the parameters R and A. A specific list of such experiments is given. (auth)

17509 EXCHANGE DEGENERACY OF VECTOR AND TENSOR TRAJECTORIES AND THE TOTAL CROSS SECTIONS. Shiga, Kunio; Uehara, Masayuki (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 44: 1417-18(Nov 1970).

The breaking of the exchange degeneracy of the vector and tensor trajectories and its implications for π^+p, k^+p, and k^+n interactions are discussed. (L.B.S.)

17510 BARYONIC FIXED POLES IN MESON–BARYON SCATTERING. Kayser, Boris (Northwestern Univ., Evanston, Ill.). Phys. Rev., D; 3: 747-55(1 Feb 1971).

By using a fixed-pole sum rule, it is established that there is a fixed pole at $J = -\frac{1}{2}$ in the πN partial wave amplitude containing the nucleon trajectory. Whether the dip at $u = -0.13$ GeV^2 in backward π^+p scattering is due to a nucleon wrong-signature nonsense zero then depends on how this fixed pole and the nucleon pole combine. A class of meson-baryon amplitudes expected to be free of nonsense fixed poles is identified. (auth)

17511 ASYMPTOTIC HELICITY CONSERVATION AND PION–NUCLEON DYNAMICS. Cheng, Wen-kwei (Stevens Inst. of Tech., Hoboken, N. J.); Dutta-Roy, Binayak; Renninger, George. Phys. Rev., D; 3: 704-11(1 Feb 1971).

Motivated by the hypothesis of the asymptotic conservation of helicity, the hypothesis that the P and P′ Regge trajectories decouple from the A^+ amplitude for pion–nucleon scattering is exploited. From the vantage point of recent theoretical developments, viz., the concept of duality and the Freund–Harari conjecture, a set of dispersion relations is selected, by means of which is shown, in good agreement with what is known, the correlation between low-energy resonances in the direct channel and non-Pomeranchukon t-channel exchanges. Furthermore, it is shown that there exists a dynamical limit in which the t-channel (ρ and σ) exchanges decouple, thus providing a new insight into the relationship between the present approach and the Chew–Low model, the reciprocal-bootstrap, and the strong-coupling theories Finally, some remarks of a speculative nature are given. (auth)

17512 MODIFIED SCALING LAW FOR LARGE-ANGLE πN SCATTERING. Cornwall, John M. (Univ. of California, Los Angeles); Levy, Donald J. Phys. Rev., D; 3: 712-19(1 Feb 1971).

The large-angle high-energy πN elastic amplitude is conjectured to obey a modified scaling law, which states that this amplitude is of the form $F(t)H(-t/s)$, where t is the momentum-transfer variable, s the energy variable, and F(t) a vector form factor. The presence of the function H, which depends only on the ratio of large kinematical variables, suggests a connection with Bjorken's scaling law for electroproduction. Such a form is in good agreement with the large-angle data currently available. The conjecture is based on (1) pion current commutators applied to mass-shell amplitudes, and (2) Feynman-graph experiments motivated by recent calculations in the eikonal (small-angle) region. (auth)

17513 SINGLE-PARTICLE EXCHANGEABLE MODEL OF INELASTIC PION–NUCLEON INTERACTIONS. Rus'kin, V. I.; Golyak, I. G.; Kosmachev, O. S. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 13-24(Mar-Apr 1968). (In Russian).

The main results of a comparison of the single-particle exchange model of inelastic pion–nucleon interactions with experiment in the energy range from 1 to 8 GeV are discussed. (tr-auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 17953.

17514 (INR-P-1222) Λ-EXCITED STATES OF HYPERNUCLEI. Deloff, A.; Pniewski, J. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 13p. Dep. NTIS (U. S. Sales Only).

Excited Λ-states of hypernuclei by means of optical potential model are considered. A realistic Saxon–Woods potential is simulated by an equivalent square well potential. The positions of the levels are calculated in terms of the mass number A of the core nucleus. The spread in binding energies due to uncertainties in the value of parameters characterizing the optical potential is discussed. (auth)

17515 (JINR-P2-5549) CLASSIFICATION OF INELASTIC INTERACTIONS OF HIGH-ENERGY PROTONS WITH NUCLEI. II. CHARACTERISTICS OF LOW-ENERGY PARTICLES. Barashenkov, V. S.; Il'inov, A. S.; Sobolevskii, N. M.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 46p. (In Russian). Dep. NTIS (U. S. Sales Only).

On the basis of the cascade-evaporative model a detailed analysis of the low-energy component of secondary particles, produced in inelastic proton-nucleus collisions in the energy range from several dozens of MeV up to T ≈ 5 GeV, was performed. From the comparison of the calculation results with the experimental data it follows that taking into account of the effect of the non-equilibrium particle emission is of great importance. The given calculation data allow one to determine, by interpolating, the corresponding characteristics for the intermediate energy values and the other nuclei. (auth)

17516 (JINR–P2-5572) STUDY OF THE ONE-PION EXCHANGE MODEL OF THE REACTION $p + p \rightarrow p + n + \pi^+$ IN THE $I = J = 3/2$ RESONANCE APPROXIMATION AT THE PROTON ENERGY OF 660 AND 970 MeV. Suslenko, V. C.; Kochkin, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 66p. (In Russian). Dep. NTIS (U. S. Sales Only).

The aim of the given study is in clearing up an applicability of the one-pion exchange model (OPEM) /4/ to reaction $p + p \rightarrow p + n + \pi^+$ (1) in the initial proton energy region with its lower limit near 660 MeV, by comparing the calculated differential energy spectra of pions with the experimental ones. Such experimental information was collected during 1956–1969 at JINR, Dubna, the π^+-meson spectra being measured in the wide region of the lab. angles, namely, from $\Theta_\pi^{lab} = 19.5°$ up to $\Theta_\pi^{lab} = 160°$ and it can be expected to be sensitive to the assumptions of the OPE model. Remarks on the OPEM ideas and their previous verifications are given. Notations relating to reaction (1) are introduced, and the relativistic kinematics of the pions is given. The general expressions for the differential energy spectra of the particle and the expression in which the integration variables are explicitly shown are given. The OPEM squared matrix element of reaction (1), corresponding to the four Feynman diagrams is given. It was calculated under the following approximations: in all four-tail vertices of the diagrams the input of the states with $I = J = 3/2$ is only taken into account and an amplitude of the physical 33-resonance of the πN scattering is approximated by the Breit–Wigner type formula, the interference terms from the diagrams are neglected. The matrix element contains the so-called "pion-nucleon formfactor" $G(K^2)$ depending only on the transferred momentum K^2 (i.e., $\bar{t}^2$ or t^2). The most important consequence of the OPE model is the statement that if this model were applicable, the experimental data must be consistent with the calculated ones at different initial energies in the given region using everywhere the same formfactor $G(K^2)$. As a result, one can draw the following conclusions: The OPE model is applicable at the initial proton energy region near T = 660 MeV because of good agreement with experiment and the same previous result for the energy region T = 0.9 – 2.85 GeV was obtained using the same formfactor and off-shell corrections, the form of the pion spectra is essentially dependent on the presence of the 33-resonance in the matrix element and its dependence on the function $\Gamma(K^2)G(K^2)$ is weaker, and the absolute values of the calculated pion spectra are strongly dependent on the choice of the function $\Gamma(K^2)G(K^2)$. Finally, the result of the calculation for the integrated energy spectrum of pions for T = 660 and 970 MeV is given using two different functions $\Gamma(K^2)G(K^2)$. (auth)

17517 (ORNL-TM-3132) PHENOMENOLOGICALLY DETERMINED ISOBAR ANGULAR DISTRIBUTIONS FOR NUCLEON–NUCLEON AND PION–NUCLEON REACTIONS BELOW 3 GeV. Bertini, Hugo W.; Guthrie, Miriam P.; Culkowski, Arline H. (Oak Ridge National Lab., Tenn.). 7 Dec 1970. 105p. Dep. NTIS.

The angular distribution of the isobars in the Lindenbaum–Sternheimer isobar model was determined phenomenologically for single and double π-meson production in nucleon–nucleon collisions and for single π-meson production in π-nucleon collisions in the energy region below a few GeV. It was assumed that

only the $\frac{1}{2},\frac{3}{2}$ isobar was excited and that it experienced s-wave decay in its own rest system. The entire range of mass values, consistent with conservation of energy, was assumed to be available to the isobars. The isobar angular distribution was constructed by first comparing experimental data with results from a calculation in which it was assumed that the isobar was created with an isotropic angular distribution. Then the same experimental data were compared with results from an identical calculation except that it was assumed that the isobar was created with a forward–backward distribution. Using different percentages of each distribution for different energies and incident particles, composite distributions were then formed by judgment in an attempt to obtain reasonable representations of the experimental data. (auth)

17518 NONSTRANGE BARYON–BARYON RESONANCES. Zul'karneev, R. Ya.; Rozanova, A. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz.; 59: 1444-7 (Oct 1970). (In Russian).

Two peculiarities of the pp-interaction mechanism in the 300 to 640 MeV range are noted. On basis of a phenomenological analysis of pp scattering at 640 MeV carried out under the assumption that in the $^1D_2$ and $^3P_2$ states of the pp system there is a strong absorption, it is demonstrated that the hypothesis is consistent with all analyzed data on pp scattering and with the total cross sections at 640 MeV. From a study of the energy dependence of the pp scattering partial amplitudes based on the Argand diagrams derived from phase shift analysis, it is concluded that a resonance may exist in a pp system (i.e. Y = B = 2) with a mass M = 2050 ± 90 MeV and $I^P = 2^+$. Attention is drawn to the fact that the hypothesis proposed agrees with the experimental data on the energy dependence of the cross section for singlet pp scattering over an angle of 90° in the c.m.s.; the dependence has a peak at energies between 300 and 550 MeV. For final elucidation of the nature of this peak further experimental and theoretical investigations are necessary. (auth)

17519 NUCLEON STRUCTURE EFFECTS IN PROTON–PROTON BREMSSTRAHLUNG. Nyman, E. M. (Research Inst. for Theoretical Physics, Helsinki). Nucl. Phys.; A160: 517-22 (1971).

The cross section for proton-proton bremsstrahlung depends on the electromagnetic structure of the protons through two form factors. It is found that if these are evaluated from dispersion relations assuming threshold dominance, the theoretical bremsstrahlung cross sections are incompatible with the available data, except at very low energies. This holds with any reasonable assumptions about the off-shell proton-proton interaction. Agreement with experiments can easily be obtained by abandoning the threshold-dominance assumption for one of the form factors. This makes it difficult to use bremsstrahlung data as tests for models of the proton-proton interaction. (auth)

17520 HIGHER SYMMETRIES AND NUCLEAR FORCES. El-Ghabaty, Sayed S.; Gupta, Suraj N.; Weihofen, William H. (Wayne State Univ., Detroit). Phys. Rev., D; 3: 769-74(1 Feb 1971).

The pion–nucleon couplings resulting from the U(6,6) model and the chiral-dynamical model are applied to the investigation of the nucleon–nucleon scattering. It is shown (a) that in the U(6,6) model the one-pion-exchange (OPE) contribution differs from the usual result only in short-range effects, while the two-pion-exchange (TPE) contribution is highly divergent; and (b) that the chiral-dynamical model leaves the usual OPE contribution unchanged, but leads to a significant modification of the usual TPE contribution. (auth)

17521 NUCLEON–NUCLEON SCATTERING PHASE PARAMETERS IN HIGHER-SYMMETRY MODELS. Barker, Bruce M. (Louisiana State Univ., Baton Rouge); Haracz, Richard D. Phys. Rev., D; 3: 775-9(1 Feb 1971).

The one-pion-exchange (OPE) and two-pion-exchange (TPE) contributions arising from the U(6,6) and chiral-dynamical models are used to obtain the corresponding nucleon–nucleon phase parameters for various energies in the elastic scattering range. It is shown that the U(6,6) OPE phase parameters differ from the usual OPE results only for s and p waves. The chiral-dynamical model, on the other hand, gives rise to an additional TPE contribution that has a comparable range and is as large as the usual TPE values. For values of L greater than 3, this additional TPE contribution tends to cancel the usual TPE values. (auth)

17522 PION PRODUCTION BY PROTONS ON ^{12}C. Reitan, A. Ark. Fys. Seminar Trondheim; No. 1, (1971).

The reaction $^{12}C(p,\pi^+)^{13}C$ at 600 MeV is studied in a model in which the pion is emitted by one of the bound nucleons and rescattered by the incident proton through the 3,3 resonance. When harmonic-oscillator wave functions are used it is found that this process gives a larger contribution to the cross section than direct pion emission by one nucleon. Damping of the incoming and outgoing waves is taken into account in the Glauber model. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 17406, 17420, 17565, and 17586.

17523 (JINR–E2-5229) ALGEBRAIC REALIZATION OF UNITARY SYMMETRY. Ogievetsky, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 9p. Dep. NTIS (U. S. Sales Only).

The algebraic realization of the SU_3 symmetry is considered. The necessity of nonets is motivated. The mass sum rules derived are satisfied to a great accuracy for the well established supermultiplets providing new predictions for nonets in which not all the members are established to date. (auth)

17524 DESCRIPTION OF PHASE SHIFTS BY MEANS OF VECTOR PARAMETERS. Tkharev, E. E. (Radiotechnical Inst., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 3, 93-6(1970). (In Russian).

On the basis of a complex vector parameter of the Lorentz group, a variation of the phase shift for particle position with an arbitrary Lorentz transformation is considered. It is shown that the phase shift connected to the rotation of the spin reference frame of three orthogonal complex vectors $q_i = c_i + (c_i,p)/\rho_0$ (where $\rho = (p,\rho_0)$–particle momentum ($m \neq 0$), c_i – three arbitrary real vectors) in the complex space of the parameters of the corresponding little group around the axis of the spin projections determining the vector q_3; also a convenient method of calculating the phase shifts is presented. (tr-auth)

17525 APPLICATION OF THE DUALITY BETWEEN REPRESENTATIONS AND CLASSES. De Vries, E.; Van Zanten, A. J. (Univ., Groningen, Netherlands). Physica; 49: 532-5(16 Nov 1970).

Starting from the principle of duality between representations and classes of groups of finite order a 3k-symbol is defined in close analogy to the well-known 3j-symbols. For these 3k-symbols a relation is derived which may be considered as a supplement to Burnside's formula for the dimensions of the irreducible representations. (auth)

17526 NUMBER OF ROOTS OF CERTAIN EQUATIONS IN FINITE SIMPLY REDUCIBLE GROUPS. Van Zanten, A. J.; De Vries, E. (Univ., Groningen, Netherlands). Physica; 49: 536-48(16 Nov 1970).

By means of Racah algebra the number of solutions of equations of the form $X^nY^m \ldots X^p \ldots Y^q \ldots Z^r = S$ (n, m, p, q, r = 0, ±1, ±2, ...) is determined. The X, Y, ..., Z lie in classes C_k, C_l, ..., C_m. As an application the number of pairs of commuting elements, one taken from class C_k and the other from class C_l, is calculated. (auth)

17527 COHOMOLOGICAL TOPICS IN GROUP THEORY. Gruenberg, Karl W. Lecture Notes in Mathematics. Volume 143. Berlin; Springer-Verlag (1970). 293p. DM 20,-.

Cohomology is presented as a tool for the study of groups. The topics covered are fixed-point free action, the cohomology and homology groups, presentations and resolutions, free groups, classical extension theory, and cohomological machinery. Also discussed are finite p-groups, the cohomological dimension, the general theory of extension categories, module theory, and finite groups in extension categories. (J.F.P.)

17528 INTERNAL SYMMETRIES ON THE BOOTSTRAP HYPOTHESIS. Capps, Richard (Purdue Univ., Lafayette, Ind.). pp 213-30 of Topics in Theoretical Physics. /Riska, Dan Olof (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The induction of symmetries in bootstrap models is considered. A brief history of symmetry induction, the N/D method, Reggeism, superconvergence, finite-energy sum rules, and symmetry breaking are discussed. (J.F.P.)

17529 WIGNER COEFFICIENTS FOR THE GROUP E(2). Gottlieb, H. P. W. (Cambridge Univ., Eng.). J. Math. Phys. (N. Y.); 12: 39-44(Jan 1971).

The Wigner coefficients for the faithful unitary representations of the 2-dimensional Euclidean group are derived from two iden-

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tities involving Bessel functions. Since the multiplicity in the decomposition of a direct product is two, two sets of coefficients are found which are real and mutually orthogonal and symmetric and antisymmetric, respectively, under interchange of constituent representations. Properties of the coefficients at the ends of the decomposition spectrum are discussed. (auth)

17530 UNITARY IRREDUCIBLE REPRESENTATIONS OF THE GROUPS $SO_0(n,1)$. Schwarz, Fritz (Univ. of Texas, Austin). J. Math. Phys. (N. Y.); 12: 131-9(Jan 1971).

By $SO_0(n,1)$ the identity component of the group O(n,1), by so(n,1), the Lie algebra of $SO_0(n,1)$ is denoted. All those representations of the Lie algebras so(n,1) are determined which can be extended to a unitary irreducible representation of the group, and explicit expressions for the generators are given. The general results are specialized to the cases n = 2, 3, 4, and 5. (auth)

17531 CONFORMAL CHARGE CONJUGATION. Hristev, Anatole P. (Univ., Bucharest). J. Math. Phys. (N. Y.); 12: 118-24(Jan 1971).

Conformal spinor calculus for an arbitrary Euclidean space E_n, n even, $n = 2\nu$, is developed, and fundamental spin tensors for Clifford algebra Cl_{n+2} of the space of representation E_{n+2} are calculated. It is found that the conformal charge conjugate of a 2^ν-semispinor ψ^i_c differs from the relativistic, conventional φ^i_c, by the permutation of the semispinors and the factor $\gamma_{n+1} = (1/n!)(i^{t-\nu}/|g|^{\frac{1}{2}})\gamma_{[1}\ldots\gamma_{n]}$, t = number of timelike dimensions of E_n; namely, $\psi^i_c = \mp\gamma_{n+1}\varphi^i_c$ for ν even, t odd. This is related to the Pauli–Gürsey isospin group. The transformation laws for spinors and conjugate spinors under conformal group are studied. Conformal identities for matrix elements and bilinear covariants are indicated. (auth)

17532 FIELDS ON A HOMOGENEOUS SPACE OF THE POINCARE GROUP. Kihlberg, Arne (Inst. of Theoretical Physics, Goteborg). Ann. Inst. Henri Poincare, Sect. A; 13: No. 1, 57-76(1970).

Fields describing one particle or an infinite number of particles are defined in an eight-dimensional homogeneous space of the Poincare group. The relativistic invariance and causality properties are discussed in particular in connection with a local coupling of the fields. (France)

17533 DECOMPOSITION OF THE TENSORIAL PRODUCT OF TWO REPRESENTATIONS OF THE POINCARE GROUP. CASE WITH AT LEAST ONE IMAGINARY MASS. Bertrand, J. (Univ., Paris). Ann. Inst. Henri Poincare, Sect. A; 13: No. 2, 163-94(1970).

The Clebsch–Gordan coefficients corresponding to the tensorial product of the following representations of the Poincare group are calculated: one real mass representation and one imaginary-mass representation, or one zero-mass representation and one imaginary-mass representation, or two imaginary-mass representations. An expression valid for all tensorial products is obtained. (France)

17534 CLASS OF SOLVABLE LIE GROUPS AND THEIR RELATION TO THE CANONICAL FORMALISM. Tilgner, Hans (Philipps-Univ., Marburg, Ger.). Ann. Inst. Henri Poincare, Sect. A; 13: No. 2, 103-27(1970).

Some facts concerning symplectic vector spaces, their automorphism groups Spl(2n, R, E), and derivation Lie algebras Spl(2n, R, E) are given. For every element R of these Lie algebras a solvable Lie group exp(RR) × E × R is constructed, which is nilpotent if R is nilpotent. The Lie algebras RR ⊕ E ⊕ R of these groups, all of which contain the Heisenberg Lie algebra, are calculated. Automorphism groups and derivation Lie algebras of RR ⊕ E ⊕ R, and faithful finite dimensional representations of them together with the corresponding representations of exp(RR) × E × R are given. A modification weyl(E, σ) of the universal enveloping algebra of the Heisenberg Lie algebra is defined. The Lie algebras RR ⊕ E ⊕ R are realized in this algebra. Finally some automorphisms and derivations of RR ⊕ E ⊕ R are constructed by means of the adjoint representation of weyl(E, σ). Attention is given to the case of the harmonic oscillator and especially to the free nonrelativistic particle whose group is nilpotent. (France)

17535 IRREDUCIBLE RAY REPRESENTATIONS OF THE FULL INHOMOGENEOUS GALILEI GROUP. Brennich, R. H. (Univ., Munich). Ann. Inst. Henri Poincare, Sect A; 13: No. 2, 137-61(1970).

Out of the discrete symmetries space-inversion, time-inversion, space-time-inversion and the universal covering group of the inhomogeneous Galilei group, a covering group of the full inhomogeneous Galilei group is constructed. The continuous multipliers on this covering group are calculated, and all those continuous irreducible ray representations, in accordance with the restriction that the unit component of the group has a nontrivial multiplier or is of class II in the Inonu Wigner nomenclature, are constructed. The direct product of two irreducible multiplier representations of the covering group is decomposed into its irreducible components. Applications to nonrelativistic quantum theory are examined. (France)

17536 SPECTRUM-GENERATING NILPOTENT GROUP FOR THE RELATIVISTIC FREE PARTICLE. Tilgner, Hans (Philipps-Univ., Marburg, Ger.). Ann. Inst. Henri Poincare, Sect. A; 13: No. 2, 129-36(1970).

A full pseudo-orthogonal group is embedded into the symplectic and antisymplectic matrices of a vector space containing the variables position, time, momentum, and energy. By means of the relativistic mass operator a nilpotent Lie group, which is to describe after unitary representation the physical concepts of mass, position, time, momentum, energy, space inversion, and time reflection of a relativistic free particle, is defined. The relation to the canonical Weyl algebra of relativistic quantum mechanics is given. (France)

17537 INDUCED REPRESENTATIONS OF THE (1 +4) DE SITTER GROUP IN AN ANGULAR MOMENTUM BASIS AND THE DECOMPOSITION OF THESE REPRESENTATIONS WITH RESPECT TO REPRESENTATIONS OF THE LORENTZ GROUP. Strom, Staffan (Inst. of Theoretical Physics, Goteborg). Ann. Inst. Henri Poincare, Sect. A; 13: No. 1, 77-98(1970).

An explicit angular momentum basis is used in the construction of the induced unitary irreducible representations of the (1 + 4) de Sitter group, belonging to the principal continuous series. In the description of the covering group of the (1 + 4) de Sitter group use is made of groups of 2 × 2 quaternion matrices in a formalism similar to the SL(2, C) description of the Lorentz group. These representations of the de Sitter group are decomposed with respect to unitary representations of a noncompact subgroup. The latter is isomorphic to the covering group of the Lorentz group. The general features of the decomposition are established by means of global methods. Possible applications are indicated. As an example the derivation of a decomposition formula for matrix elements of finite transformations is treated in some detail. (France)

Applications (Electromagnetic and Weak)

Refer also to abstract 17460.

17538 BROKEN SYMMETRIES AND SCALE TRANSFORMATIONS. Eberle, E. (Univ., Genoa, Istituto Nazionale di Fisica Nucleare, Genoa). Lett. Nuovo Cim.; 1: 68-70(9 Jan 1971).

Some features of scale transformations for use in the study of broken internal symmetries are pointed out. These scale transformations are used to investigate the problem of how to attain the hypothesized symmetrical limit in broken internal symmetries. The hypothetical limit mass is studied in the case of two-body leptonic π and K decays. (J.F.P.)

17539 STUDY OF THE DECAY PROCESS $K \to \pi e\nu\gamma$ WITH REGARD TO THE SEARCH FOR TIME-REVERSAL VIOLATION. Schutz, Stephen A. Princeton, N. J.; Princeton Univ. (1970). 126p. University Microfilms Order No. 70-23,637.

Thesis.

Decays of the form $K \to \pi e\nu\gamma$ are particularly interesting as a place to look for the effect of time reversal violation, because the time reversal violating effects can show up as triple vector product correlations of momenta, without regard to polarization measurements. The measurement of triple vector product correlations is not a pure test of time reversal invariance because the existence of final state interactions can also produce such correlations. The effects of the final state interactions for $K \to \pi e\nu\gamma$ were calculated and found to be very small, so that these decays are still good candidates for experiments in the search of time reversal violation. The most general amplitude for the decay $K \to \pi e\nu\gamma$ is written down in terms of the inner bremsstrahlung terms and the structure dependent terms. The most general structure dependent term, consistent with electromagnetic current conservation and embodying the assumption that the leptons interact at a point via the usual leptonic current, is written down in terms of eight (six for the electron case) unknown invariant structure functions. The unintegrated differential rate and lepton polarization spectrum are expressed as the sum of a series of terms involving progressively higher powers of the photon energy. If there is a large time reversal violation in the electromagnetic interactions one might expect it to give rise to

a large time reversal violation in the structure dependent part of the decay $K \rightarrow \pi e\nu\gamma$. Consequently, it is useful to estimate the size of the structure dependent terms relative to the inner bremsstrahlung terms. It is found that for a low photon energy cutoff of 100 MeV the ratio of the inner bremsstrahlung part of the decay rate for $K^{\pm} \rightarrow e^{\pm}\pi^0\nu\gamma$ to the decay rate for $K^{\pm} \rightarrow e^{\pm}\pi^0\nu$ is approximately $.28 \times 10^{-2}$. Based on the evaluation of the lowest pole diagrams, the structure dependent contribution for this value of the photon energy cutoff is estimated to be about 3% as large as the inner bremsstrahlung contribution. Graphs of the photon energy spectrum are given so that similar information can be obtained for different values of the photon energy cutoff. (Diss. Abstr. Int., B)

17540 CP VIOLATION: INTERFERENCE EFFECTS IN K^0 DECAY. Coulter, Philip W.; Shaw, Gordon L. (Univ. of California, Irvine). Phys. Rev., D; 3: 779-83(1 Feb 1971).

The intrinsic magnitude of the CP-violating coupling is not simply related to the decay ratio $(K_L \rightarrow 2\pi)/(K_S \rightarrow 2\pi)$, because of the K_L-K_S overlap. It is this intrinsic coupling which is needed to estimate CP violation in other systems. An explicit model showing the interference effects of the K_L-K_S overlap on the relation of the coupling constants to the above decay ratio is examined. There are interference effects in ϵ which depend on nonmeasurable mass shifts. (Theoretical estimates of these mass shifts are discussed.) However, ϵ' does not depend on these mass shifts and thus can be more easily related to the intrinsic CP-violating coupling. (auth)

17541 CHIRAL SYMMETRY AND η–X MIXING. Kobayashi, Makoto (Nagoya Univ., Japan); Maskawa, Toshihide. Progr. Theor. Phys. (Kyoto); 44: 1422-4(Nov 1970).

The mass relation between η and X is examined under the assumption that the symmetry breaking part of the hadron energy density belongs to the representation $(3^*,3) + (3,3^*)$ of chiral $SU(3) \times SU(3)$. (L.B.S.)

Applications (Strong)

Refer also to abstracts 17468, 17488, and 17520.

17542 20'S, EVEN-PARITY 70'S, AND ODD-PARITY 56'S. Faiman, D. (Oxford Univ.). Lett. Nuovo Cim.; 4: 1231-4(19 Dec 1970).

An experimental search is suggested for certain baryon resonances whose existence could help determine the relative merits of various symmetry schemes that have been proposed for the baryon spectrum. It is suggested to examine those states predicted by the harmonic-oscillator quark model that have unique quantum numbers within each excitation level, and which can accordingly mix with no states closer in energy than two quanta of excitation. (L.B.S.)

17543 DASHEN PARADOX, DOMAINS OF MATHUR, AND OKUBO AND KUO INVARIANCE. Bandelloni, G. (Univ., Genoa). Lett. Nuovo Cim.; 1: 61-4(9 Jan 1971).

It is shown that the paradox of the possibility of negative eigenvalues of the square-mass matrix of Goldstone bosons in a spontaneously broken $SU(3) \times SU(3)$ is easily explained when values for the breaking terms are restricted to Mathur and Okubo domains. Mass values and sum rules are thus obtained, and their behavior is studied under Kuo transformation. A manifest Kuo invariance for zero-hypercharge renormalized bosons is derived; for strange bosons, the Kuo transformation changes the masses of the particles into those of opposite parity. This fact is interpreted as a new definition of parity for these particles which does not change the physical description of the system, owing to the arbitrariness of the relative parity of particles with nonzero hypercharge. (J.F.P.)

17544 ASYMPTOTIC SU(3) AND SU(2) SYMMETRIES. Oneda, S. (International Centre for Theoretical Physics, Trieste, Italy. Univ. of Maryland, College Park); Matsuda, Seisaku. Nucl. Phys.; B26: 203-14(1971).

Formulation of an idea of asymptotic SU(3) and SU(2) symmetries which are compatible with the Gell-Mann-Okubo (GMO) and the SU(2) mass splittings (including mixings) is discussed. Consequences of the application of these asymptotic symmetries so far obtained are briefly reviewed. Combined with the use of suitable equal-time commutation relations involving the generators of these groups and also their time derivatives, these asymptotic symmetries require that there exist rather simple SU(3) and SU(2) inter-multiplet regularities among the mass spectra of hadrons. Broken SU(3) and SU(2) sum rules obtained by using asymptotic symmetries exhibit simple but sometimes very significant modifications of exact SU(3) and exact SU(2) sum rules through the appearance of the physical masses and the mixing parameters in the sum rules. (auth)

17545 PARITY-VIOLATING INTERNUCLEON POTENTIAL IN NUCLEAR REACTIONS OF THE n–p SYSTEM. Hadjimichael, E. (State Univ. of New York, Stony Brook. Fairfield Univ., Conn.); Fischbach, Ephraim. Contracts 31-6028B; AT(30-1)-3668B. Phys. Rev., D; 3: 755-61(1 Feb 1971).

The parity-violating nucleon-nucleon interaction arising from weak one-pion exchange and one-vector-meson exchange, was added to the strong, semiphenomenological nucleon-nucleon interaction and its effects on the n–p system were studied in detail. The parity admixtures in the initial and final states of the n–p system in deuteron photodisintegration and in radiative n–p capture have been calculated for various models of the weak-interaction Hamiltonian H_w and found to be in the range 10^{-3}–10^{-7} depending on the model of H_w, thus allowing for the possibility of discriminating among models of H_w by comparison to experiment. (auth)

17546 MODEL HAMILTONIAN FOR LOW ENERGY BARYON PSEUDO-SCALAR MESON SCATTERING. Redei, L. B. (Umea Univ., Sweden). Ann. Inst. Henri Poincare, Sect. A; 13: No. 1, 99-102(1970).

A broken SU_3 relativistic equation is solved to obtain the masses of the baryon resonances. The potential is obtained by making an off energy shell extrapolation of the baryon exchange Born term derived from an SU_3 symmetric Lagrangian. The breaking of SU_3 symmetry is introduced by using the physical masses for the baryons and the mesons. The value of the pion-nucleon coupling constant is determined by requiring the model to reproduce the mass of the $N^*_{\frac{3}{2}}$(1238) resonance. The mass was found to be approximately linearly dependent upon the inverse power of the coupling constant and $g^2/4\pi = 38$. (France)

Field Theories

General

17547 FIELD-THEORETIC DESCRIPTION OF MASSLESS PARTICLES WITH HIGHER SPIN AND DEFINITE PARITY. II. HALF-INTEGER SPIN. Cukierda, T. (Univ. of Wroclaw). J. Math. Phys. (N. Y.); 12: 36-9(Jan 1971).

The $S + \frac{1}{2}$ equivalent theories describing a free massive field with half-integer spin S in the limit $M \rightarrow 0$ are investigated. It is shown that for $m = 0$ they are not equivalent and describe different massless particles, with helicities $H = \pm\frac{1}{2}, \pm\frac{3}{2}, \cdots, \pm S$. The inequivalence is caused by the possibility of having different gauge transformations for different massless spinor–tensors $G^{k}_{\dot{\alpha}\cdots(\mu\nu)A}$. (auth)

17548 NEW APPROACH TO THE NOETHER THEOREMS. Plybon, Benjamin F. (Miami Univ., Oxford, Ohio). J. Math. Phys. (N. Y.); 12: 57-60(Jan 1971).

The Noether theorems were derived by Noether for n-dimensional Euclidean spaces, but they have been used in relativistic theories where the geometry is not Euclidean. A derivation of the Noether theorems, is given assuming only a Riemannian space and following the method used by Noether as closely as possible. This requires new definitions of total variations for fields and integrals since a covariant total variation for tensor fields is required. The results have been applied to electromagnetic fields. (auth)

17549 CLASSICAL SCALAR FIELD THEORIES AND THE RELATIVISTIC KEPLER PROBLEM. Andersen, C. M.; von Baeyer, Hans C. (Coll. of William and Mary, Williamsburg, Va.). Ann. Phys. (N. Y.); 62: 120-34(Jan 1971).

Two versions of classical relativistic field theory corresponding to massless scalar exchange are compared. It is found that they lead to identical field equations but different equations of motion. The motion of one particle bound by the field of another, infinitely massive particle, i.e., the Kepler problem, is examined. In one case the path is an ellipse precessing through an angle equal to minus one-sixth the value predicted by general relativity. In the other case the path is an ellipse which does not precess. The relativistic Kepler problem in the latter case is identical to that formulated by Fronsdal, who started from an approximation to the Bethe–Salpeter equation. (auth)

17550 THEORY OF ZERO-MASS FERMIONS. Smirnov, L. I. (Leningrad Electro-Technic Inst.). Teor. Mat. Fiz.; 6: 87-9 (Jan 1971). (In Russian).

The existence of two types of zero-mass fermion fields is shown. These fields differ from Dirac and Weyl fields. The free field theory is constructed for both types of fields. (auth)

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17551 DIVERGENCE OF AXIAL-VECTOR CURRENT IN THE GRAVITATIONAL FIELD. II. ANOMALOUS COMMUTATORS AND MODEL THEORY. Kimura, Toshiei (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 44: 1353-70(Nov 1970).

It is attempted to derive the anomalous commutators of the axial-vector current and the gravitational field variables by the reduction formula and the Bjorken-Johnson-Low limiting procedure for the axial-vector current-two graviton matrix element. For this purpose, the additional Lagrangian density for the gravitational field is introduced so that the gravitational interaction reduces to a renormalizable one. In spite of such a technique, the derived commutators are not consistent except for several ones and show that the Bjorken-Johnson-Low behavior does not hold in a strict sense. With the aid of the commutators which seem to be rigorous, the other commutators are determined so as to be consistent with each other, with the divergence equation and with the quantization procedure of the gravitational field. In the second place, a model is presented to confirm the appropriateness of the anomalous commutators. By setting out the field-current identity and the canonical commutators, the divergence equation of the axial-vector current is derived. The additional gravitational Lagrangian density plays an important role also in this model. Finally, the relation between the two methods is discussed. (auth)

Quantum Field Theory

Refer also to abstracts 17406, 17476, 17532, 17595, and 17603.

17552 (AD-711404) THEORY AND APPLICATIONS OF PADE APPROXIMANTS AND QUANTUM FIELD THEORY. Final Scientific Report, October 1968-June 1970. Chisholm, J. S. R. (Kent Univ., Canterbury (England)). 29 Jul 1970. 13p. (AFOSR-70-2346-TR). NTIS.

Preliminary investigations of the application of the Pade technique to sequences of approximants to single-variable integrals show that existing integration methods can be improved upon, particularly when the integrands are singular or are infinitely oscillating. Series of derivatives of δ-functions were investigated (a) term-by-term as a generalized function and (b) by forming Pade approximants of the Fourier transformed series. When the latter series is a series of Stieltjes, convergence of the approximants in interpretation (b) is established, to the generalized function defined by interpretation (a). Study has begun on solving linear integral equations of the form $f = g + \lambda Kf$ by forming the Pade approximant of the Neumann series. The method appears to work, but is dependent upon the accuracy of performing multiple integrals, which is to be studied under (a) above. Simple algorithms were established which permit easy extraction of magnetic moment contributions from vertex parts in field theory. (auth)

17553 (JINR-P2-5513) QUANTIUM THEORY BY THE POINCARE GROUP. Khristov, Kh. Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 55p. (In Russian). Dep. NTIS (U. S. Sales Only).

In the direction of previous work a quantum mechanics and a quantum field theory are considered where the wave functions and the field operators depend not on the 4 coordinates in the Minkovski space M but on all 10 variables determining the inertia frames of reference i.e., the elements of the Poincaré group. P = (t,l) (t-translation vector, l-Lorentz matrix). The difference is that metrics in the space P invariant in respect to (t,l) → (s,h)(t,l)(0,k) (1) are introduced. With this the metrics are determined up to two constants (to be found by the experiment). As an example one writes and solves the equation in P, analogous to the Klein-Gordon equation in M. Further, the second quantization of this equation is given by writing the equation for the commutator, invariant in respect to (1). It was not completely solved, but it is clear that the local commutativity holds. The aim is to get nontrivial models of interaction field theories by making larger the set of solutions. (auth)

17554 (JINR-P2-5523) PROBLEM OF APPLICATION OF THE GALILEAN TRANSFORMATIONS IN QUANTUM MECHANICS. Streltsov, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1970. 5p. (In Russian). Dep. NTIS (U. S. Sales Only).

The fact, that the wave function (when transforming to the other frame of references) acquires an additional phase in the Galilean approximation, is shown to be at variance with the relativistic formula of transformation $\psi'(x',t) = \psi(x,t)$. (auth)

17555 (NYO-1932(2)-183) FINITE THEORY OF QUANTUM ELECTRODYNAMICS. Lee, T. D. (Columbia Univ., New York). Jul 1970. Contract AT(30-1)-1932. 35p. Dep. NTIS.

The treatment of the formulation of a finite theory of quantum electrodynamics covers the indefinite metric and unitarity, the modified photon and fermion fields, Feynman diagrams, experimental consequences, and causality. (J.F.P.)

17556 WAVE EQUATIONS WITH MULTIPLE LORENTZ GROUP REPRESENTATIONS: HALF-INTEGRAL SPIN. Fedorov, F. I.; Pletyukhov, V. A. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 3, 78-83 (1970). (In Russian).

The structure of matrices of relativistic wave equations of the first order, describing half-integral-spin particles, for which the set of Lorentz group representations contains representation multiples, was examined. These equations were analyzed. (J.F.P.)

17557 WAVE EQUATION WITH MULTIPLE REPRESENTATIONS FOR PARTICLE WITH SPIN 1. Pletyukhov, V. A.; Fedorov, F. I. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 3, 84-92(1970). (In Russian).

A relativistic wave equation for spin-1 particles was constructed using the twofold vector representation of the Lorentz group. The dimension of the matrices γ_k is 15. The minimal equation has the form $\gamma^3(\gamma^2 - 1) = 0$. Scattering of the studied vector particle in the electrostatic field occurs also, as in the case of the spin-1 Duffin-Kemmer particle. Matrix elements of Compton scattering differ from the corresponding Duffin-Kemmer scattering. (tr-auth)

17558 FOUNDATIONS OF GAUGE THEORY. Peak, David. Albany, N. Y.; State Univ. of New York (1970). 116p. University Microfilms Order No. 70-25,472.

Thesis.

The mathematical basis for a local gauge theory of the type suggested by Yang and Mills is made precise. The gauge fields of the conventional theory are presented as components of differential forms related to a principal fiber bundle with the gauge group for structure group, and the space-time manifold for base space. The gauge fields are then seen to be intimately connected to the Lie algebra associated with the gauge group. Several conditions are presented under which the gauge fields vanish everywhere (an empty gauge theory). The bundle structure strongly insinuates that the relation between the space-time symmetries and the internal symmetries of physical fields greatly influences the nature of the local gauge theory dealing with those internal degrees of freedom. In particular, under certain assumptions the existence or nonexistence of gauge particles is shown to completely determine the internal-external relation. The difficulties inherent in attempting to formulate a consistent local gauge theory for the strong interactions are considered primarily. A simple model is proposed in which the mass of the gauge particle is viewed as a breaking agent for the hadronic symmetries. Qualitative descriptions of the existence of massless bosons associated with a broken symmetry, the geometrical structure of the extended hadron, and the possible significance of Mach's principle in the very small are all elicited from the model. (Diss. Abstr. Int., B)

17559 RELATIVISTIC QUANTUM MECHANICS OF SCALAR BOSONS. Walter, John Fitler. Philadelphia; Drexel Inst. of Tech. (1970). 119p. University Microfilms Order No. 70-23,250.

Thesis.

A discussion of the relativistic theory of the quantum mechanics of scalar bosons is given, and the general procedures are developed for and then applied to the solution of elementary physical problems. For the case of external electromagnetic fields, the bound state eigenvalue problem and the stationary-state scattering problem are considered in a time-independent formulation. In a time-dependent formulation scattering and pair annihilation are considered for unnormalized wave functions for infinite times and also for wave packets for finite times. In the case of the bound-state problem, the energy levels are obtained, but one must introduce quasi-stationary states in order to obtain a reasonable probabilistic interpretation. The regular scattering cross section is obtained from both the time-independent and the time-dependent formulations, but the annihilation cross section can only be obtained from the latter. This cross section is of much smaller magnitude than the regular scattering cross section. The calculations for wave packets are done numerically and the results are present graphically. It is found that the probability for pair annihilation is small for ordinary electromagnetic field intensities. The expression for the spread of a free particle represented by a Gaussian wave packet is also determined. Finally the equations of motion for the boson in interaction with the dynamic electromagnetic field are determined using gauge-independent coordinates and the Hamiltonian formulation of theories with constraints. This approach avoids

the difficulties encountered in the specification of the boundary conditions due to the constraints. (Diss. Abstr. Int., B)

17560 LORENTZ INVARIANCE AND NORMAL PRODUCT. Taguchi, Yukio (Univ. of Osaka Prefecture); Yamamoto, Kunio. Progr. Theor. Phys. (Kyoto); 44: 1280-6(Nov 1970).

It is shown that the energy-momentum tensor of the free complex scalar field with a correct transformation property about the Lorentz group should be written in a normal product. A brief discussion of an interacting case is made. It is expected that in general all the local operators with definite transformation properties under the Lorentz group should be written in a normal product. (auth)

17561 APPLICATION OF THE PRINCIPLE OF THE MINIMUM MAXIMUM MODULUS TO GENERALIZED MOMENT PROBLEMS AND SOME REMARKS ON QUANTUM FIELD THEORY. Baker, George A. Jr. (Brookhaven National Lab., Upton, N. Y.), Gammel, John L. J. Math. Anal. Appl.; 33: 197-211(Jan 1971).

A method is developed for separating into component parts functions which are the difference of two series of Stieltjes, and with other related but more complex structures which occur in certain physical problems. The approach differs from the classical one in that one also can construct a convergent sequence of values to the function value throughout the cut complex plane. (auth)

17562 TWO-COMPONENT SPINOR FIELD. Marx, E. (Drexel Univ., Philadelphia). Physica; 49: 469-92(16 Nov 1970).

A theory of the classical two-component spinor field and its interpretation as a wave function in relativistic quantum mechanics is presented. Contrary to the classical Direc bispinor field, this spinor field gives rise to a conserved indefinite charge, which is the basis of the probabilistic interpretation of the wave function. First the theory of a spin-$\frac{1}{2}$ particle in an external electromagnetic field is presented, which is then extended to several identical fermions. A theory of a fixed number of particles is dealt with in which pair annihilation and creation appear in the form of a reflection of the wave packet by a potential barrier on the time axis, which changes the mode of propagation of a particle from forward to backward in time and vice versa. Also the theory of the interaction with a dynamical electromagnetic field is presented in a gauge-independent, Lorentz-covariant, observer-dependent formulation. A brief discussion of the possible quantization procedures, using commutators or anticommutators, for the spinor field follows. (auth)

17563 MATHEMATICAL PROPERTY OF DIRAC PLANE WAVES. Muraskin, M. (Univ. of North Dakota, Grand Forks). J. Math. Phys. (N. Y.); 12: 28-31(Jan 1971).

From Dirac plane waves, one can define a g_{ij}, Γ^i_{jk}, and e^q. It is found that Dirac plane waves satisfy, in addition to the Dirac equation, a set of nonlinear field equations involving these quantities. General e^q plane waves do not satisfy these equations. (auth)

17564 ELECTRODYNAMICS OF DIRECT INTERPARTICLE ACTION. II. RELATIVISTIC TREATMENT OF RADIATIVE PROCESSES. Hoyle, F.; Narlikar, J. V. (Cambridge Univ., Eng.). Ann. Phys. (N. Y.); 62: 44-97(Jan 1971).

A sequel to earlier work that described nonrelativistic quantum electrodynamics in terms of the time symmetric theory of direct interparticle action is presented. The restriction to a nonrelativistic treatment is removed. The path integral approach to quantum mechanics is extended to include relativistic particles with spin as a preliminary to achieving this end. The response of the universe can be obtained in two ways, by an extension of the previous method or by using a general condition analogous to the general condition, $\Sigma_{\text{particles}} [F_{\text{ret}} - F_{\text{adv}}] = 0$, of Wheeler and Feynman. The second method is used since it avoids the need to calculate the detailed properties of the absorber. The rules of quantum electrodynamics in the form stated by Feynman are derived, thereby showing that all the practical results of the usual theory of quantum electrodynamics can also be obtained from the direct particle theory. Radiation corrections are discussed. The direct particle theory throws some light on the processes of renormalization. The point of view that both mass and charge should be finite before as well as after renormalization is partially developed. (auth)

17565 CARRUTHERS' THEOREM FOR PARAPARTICLES. Davies, Ruth; Bloore, F. J. (Univ. of Liverpool). Progr. Theor. Phys. (Kyoto); 44: 1371-5(Nov 1970).

The group theory underlying Carruthers' theorem (that isotopic multiplets of selfconjugate bosons have integer isospin) is summarized, and a proof is given for parabosons, based on the commutation relations. (auth)

17566 DIMENSIONALITY OF SPACE–TIME. Mariwalla, K. H. (Arya-Mehr Univ. of Tech., Teheran). J. Math. Phys. (N. Y.); 12: 96-9(Jan 1971).

It is shown that, for a local Poincaré covariant quantum field theory in which the usual relation between the TCP symmetry and spin-statistic holds, the dimensionality of space–time should be even. Further plausibility arguments are presented in favor of the observed dimensionality, on basis of the following factors: simplicity, relativistic local quantum field theory, general relativity, the nature of some observed interactions, classical mechanical force concept. (auth)

17567 EXTREMUM PRINCIPLES FOR THE EQUATION $\nabla^2\phi = \phi - \phi^3$. Robinson, Peter D. (Univ. of Wisconsin, Madison). J. Math. Phys. (N. Y.); 12: 23-8(Jan 1971).

It has been conjectured that the Lagrangian functional $G(\Phi) = \int [\frac{1}{2}\Phi(-\nabla^2 + 1)\Phi - \frac{1}{4}\Phi^4]\, dr$ provides an upper bound for $G(\varphi_0)$, where φ_0 is the ground-state eigenfunction of the nonlinear field equation $-\nabla^2\varphi + \varphi - \varphi^3 = 0$, provided that $G(\Phi)$ is constrained to be stationary with respect to variations in the amplitude of Φ. It is demonstrated that this conjecture is true. The effect of a stationary-scale constraint on $G(\Phi)$ is also shown to guarantee an upper bound. Complementary functionals arising from a Euler–Hamilton approach to the problem are investigated. Unfortunately, these do not (as in more favorable circumstances) provide lower bounds for $G(\varphi_0)$, but merely alternative upper bounds. With a very simple trial function, a complementary bound is closer to $G(\varphi_0)$ than is $G(\Phi)$. (auth)

17568 PROPAGATORS OF HIGH-SPIN PARTICLES WITH SELF-ENERGY PARTS. Iwasaki, Yoichi (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 44: 1376-82(Nov 1970).

It is shown that a kind of unitarity imposes a condition on the propagators of high-spin particles. The usual propagators do not satisfy this condition, while those which have been introduced in connection with the O(4) symmetry satisfy it. The dressed propagators have poles even at lower partial waves. This fact means that a high-spin particle cannot exist by itself, but it must be accompanied by lower-spin particles. The existence of the latter may correspond to the abnormal solutions of the B–S equation. Also a difficulty of the scalar-tensor theory of the graviton is pointed out. (auth)

17569 LORENTZ INVARIANCE AND NORMAL PRODUCT IN AN INTERACTING SYSTEM. Taguchi, Yukio (Univ. of Osaka Prefecture); Yamamoto, Kunio. Progr. Theor. Phys. (Kyoto); 44: 1287-90(Nov 1970).

It is shown that from requirement of the Lorentz invariance any vector and tensor operators composed of interacting field variables should be written in a normal product, in the sense of zero vacuum expectation value, except for the term constant × $\delta_{\mu\nu}$ for the tensor operator. (auth)

17570 AXIAL-VECTOR CURRENT IN SPINOR ELECTRODYNAMICS. Akiba, Tomoya; Ebata, Takeshi (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 44: 1340-52(Nov 1970).

A formalism for the axial-vector current j^5_μ defined in spinor electrodynamics is presented in order to preserve the formal divergence relation of j^5_μ. The only deviation from the conventional way of field thoery is to introduce a simple kinematical pole in some matrix element of j^5_μ. The vertex parts of j^5_μ are divided into two parts, one contributing to $\partial^\mu j^5_\mu$ and necessarily satisfying gauge conditions, and the other giving a vanishing contribution to $\partial^\mu j^5_\mu$. It is shown that renormalization of ultraviolet divergences can be carried out without any trouble in the former, while in the latter it is difficult to keep obvious gauge invariance. Adler's low-energy theorem, which has some relevance to $\pi^0 \to 2\gamma$ decay, manifests itself as a consequence of gauge invariance and the divergence relation of j^5_μ. (auth)

17571 CAN LOCAL GAUGE TRANSFORMATIONS BE IMPLEMENTED? Dell'Antonio, G. F. (Inst. for Advanced Study, Princeton, N. J.). J. Math. Phys. (N. Y.); 12: 148-56(Jan 1971).

One studies conditions under which a gauge transformation can be implemented by a unitary operator in some representations of the canonical (anti-) commutation relations; an application is then given to local gauge transformations in field theory. (auth)

17572 PHOTON SPIN FORMALISM. Epstein, Kenneth J. J. Math. Phys. (N. Y.); 12: 125-30(Jan 1971).

A new approach to quantum electrodynamics is considered, in which photon spin terms are incorporated phenomenologically into the equations of classical electrodynamics in such a way as to yield quantized equations in the Heisenberg picture, for which relativistic requirements are satisfied. Photon momentum and energy analyses in the new formalism are then compared to the corresponding analyses in conventional field-theoretic formalisms, and

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questions regarding mathematical and physical consistency are discussed. Different notations are used to distinguish between physical and Hilbert space vectors, noting that the Hilbert space of the vector wavefunction has a 3-dimensional subspace resembling physical space, mathematically, in a way that allows interesting results, which can be described by two formalisms when auxiliary notation is necessary to analyze relations involving both kinds of vectors. (auth)

17573 DISTRIBUTIONS AND THEIR HERMITE EXPANSIONS. Simon, Barry (Princeton Univ., N. J.). J. Math. Phys. (N. Y.); 12: 140-8(Jan 1971).

A self-contained treatment of the technical parts of distribution theory needed in quantum field theory is presented. The treatment is particularly suited for physicists since an absolute minimum of abstract functional analysis is used: In fact, only the Baire category theorem is needed. The simple nature of some proofs depends on extensive use of the expansion of a distribution as a sum of harmonic oscillator wave functions. While this Hermite expansion is not new, the fact that it provides elementary proofs of several theorems does appear to be new. (auth)

17574 VALIDITY OF THE ASYMPTOTIC THEOREMS AT HIGH ENERGIES IN LOCAL QUANTIUM FIELD THEORY. Tran hu'u, Phat (Univ. de Hanoi, Viet-Nam). Acta Phys. Pol.; B1: 331-7(Oct-Dec 1970). (In French).

It is shown that it is also possible to obtain asymptotic relations in the theory of quantized fields in which the principle of causality can be modified. This means that the experimental verification of the Pomeranchuk type can give no information on the validity of the fundamental principles in quantum field theory. One cannot use the asymptotic relations as well-founded criteria in order to verify the validity of these principles. (tr-auth)

Gravitation and General Relativity

Refer also to abstracts 15877, 16733, and 16734.

17575 (AD-713140) RESEARCH IN GENERAL RELATIVITY. Final Report. Newman, Ezra T.; Janis, Allen I. (Pittsburgh Univ., Pa. Dept. of Physics). Aug 1970. Contract F33615-70-C-1081. 169p. (ARL-70-0136). NTIS.

Work in three areas of research connected with general relativity is discussed: The development of trapped surfaces; a new approach to equations of motion; and some applications of group theory to general relativity, in particular to equations of motion. (auth)

17576 CYLINDRICALLY SYMMETRIC NULL FIELDS IN GENERAL RELATIVITY. Rao, J. Krishna (Sardar Patel Univ., Vallabh Vidyanagar, India). Indian J. Pure Appl. Math.; 1: 367-71(Jul 1970).

A class of exact solutions of the cylindrically symmetric spacetime with two degrees of freedom corresponding to the field equations, $R_{ij} = \sigma\omega_i\omega_j$, $\omega_i\omega^i = 0$, is obtained. The solutions possess wave-like character and were interpreted as representing the propagation of gravitational radiation on a null field background. (auth)

17577 EINSTEIN-MAXWELL FIELDS IN THE PRESENCE OF MATTER AND PRESSURE. Goodinson, P. A.; Newing, R. A. (University Coll. of North Wales, Bangor). J. Inst. Math. Appl.; 6: 212-21(Sep 1970).

Conditions for the existence of an electromagnetic field in the presence of matter and pressure are expressed in terms of the eigenvalues and eigenvectors of the Ricci tensor. The question of the representation of conditions for a null field as the limit of corresponding conditions for a nonnull field in the absence of matter is examined from a new point of view. (auth) (UK)

17578 ASYMPTOTIC STATES OF MASSIVE PARTICLES INTERACTING WITH GRAVITATIONAL FIELDS. Kulish, P. P. (Mathematics Inst., Moscow). Teor. Mat. Fiz.; 6: 28-35(Jan 1971). (In Russian).

It is shown that analogously to quantum electrodynamics the infrared divergences do not arise in the interaction of massive particles with gravitational field, if a certain modification of the scattering operator and the space of states, on which the latter is defined, is performed. (auth)

17579 GRAVITATIONAL STRESSES. Fikhtengol'ts, I. G. (Leningrad Inst. of Precision Mechanics and Optics). Dokl. Akad. Nauk SSSR; 194: 553-6(21 Sep 1970). (In Russian).

Certain magnitudes related to the tensor of curvature and interpreted as gravitational intensities were analyzed considering mainly the harmonic coordinates. It is shown that there is a certain basis for interpreting the magnitude $(1/3\mathfrak{C})\rho_{\mu\nu}$, (where $\mathfrak{C}$ is the Einstein's gravitation constant) as the magnitude describing gravitation intensities. (R.V.J.)

17580 TIDAL GRAVITATIONAL ACCELERATIONS NEAR AN ARBITRARY TIMELIKE GEODESIC IN SCHWARZSCHILD SPACE. Finley III, J. D. (Univ. of New Mexico, Albuquerque). J. Math. Phys. (N. Y.); 12: 32-6(Jan 1971).

It is suggested that a "physical" definition of a singularity in a space-time manifold might be that it is a point where the relative accelerations of nearby timelike geodesics become infinite. Along an arbitrary timelike geodesic in Schwarzschild space, an orthonormal tetrad of 4-vectors is constructed which is used to define "elevator coordinates" in a neighborhood of the geodesic. These coordinates are used to determine the tidal gravitational accelerations near the geodesic, and it is pointed out that these accelerations are finite (and continuous) at r = 2m, the "Schwarzschild surface," although they are unbounded as r approaches 0. (auth)

17581 APPLICATION OF REGGE CALCULUS TO THE SCHWARZSCHILD AND REISSNER-NORDSTROEM GEOMETRIES AT THE MOMENT OF TIME SYMMETRY. Wong, Cheuk-yin (Princeton Univ., N. J. Oak Ridge National Lab., Tenn.). J. Math. Phys. (N. Y.); 12: 70-8(Jan 1971).

Applied to 3-dimensional space, Regge calculus approximates a curved space by a collection of tetrahedrons or other simple solid blocks. Within each block the goemetry is Euclidean. Curvature is idealized as concentrated at the edge common to two or more of these solids. Specialization is made to a static geometry endowed with spherical symmetry and to a radial electric field produced by the flux of electric lines of force trapped in a throat connecting two quasi-Euclidean regions of space. In method (1) the space is decomposed into shells separated from one another by icosahedral surfaces, all having a common center. Method (2) is even simpler: Space is decomposed into successive spherical shells of area $4\pi\rho_i^2$ separated by a proper distance d. Regge calculus gives a recurrence relation relating the dimensions of the successive shells. The approximate geometries calculated by methods (1) and (2) are compared with the well-known exact Schwarzschild and Reissner-Nordstrom geometries. Errors range from roughly 10% down to less than 1%, depending upon the method of analysis, the quantity under analysis, and the fineness of the subdivision. (auth)

17582 NONLINEAR REALIZATIONS OF SPACE-TIME SYMMETRIES. SCALAR AND TENSOR GRAVITY. Isham, C. J.; Salam, Abdus; Strathdee, J. (International Centre for Theoretical Physics, Trieste, Italy). Ann. Phys. (N. Y.); 62: 98-119(Jan 1971).

The study of conformal group symmetries within the framework of nonlinear realizations is extended and re-expressed in terms of metric tensors and connections on space-time. The standard Vierbein formalism of general relativity is then reinterpreted in terms of nonlinear realizations of the group GL(4,R). Throughout the connection between massless Goldstone bosons and the preferred fields of nonlinear realizations is emphasized. (auth)

Scattering Theory

Refer also to abstracts 16815, 17406, 17496, and 17561.

17583 (COO-264-567) DUAL LOOP TERMS AND COUNTERTERMS BY MEANS OF THEIR PROJECTIVE GROUP. Fenster, Stanley (Argonne National Lab., Ill.); Karpf, Armin D. (Chicago Univ., Ill. Enrico Fermi Inst.). Dec 1970. Contract AT(11-1)-264. 12p. (EFI-70-74). Dep. NTIS.

A unified treatment of dual loop term and counterterm by means of their projective group is presented for the one loop case. The significance of parameters in this method of linear differential equations is discussed for multi loop terms. (auth)

17584 (JINR-E2-5244) ACCOUNT OF CORRECTIONS TO THE EIKONAL APPROXIMATION IN THE QUASIPOTENTIAL APPROACH. Garsevanishvili, V. R.; Goloskokov, S. V.; Matveev, V. A.; Slepchenko, L. A.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 14p. Dep. NTIS (U. S. Sales Only).

The corrections to the eikonal approximation in the quasipotential approach of the relative order 1/p as compared to leading contributions at high energies are studied. (auth)

17585 (JINR-E2-5568) FACTORIZATION OF DUAL AMPLITUDES AND LOOPS IN THE COHERENT STATE MODEL. Kvinikhidze, A. N.; Popov, Kh. D.; Stoyanov, D. Ts.; Tavkhelidze,

A. N. (Joint Inst. for Nuclear Research, Dubna (USSR), Lab. of Theoretical Physics). 1971. 10p. Dep. NTIS (U. S. Sales Only).

In the coherent state formalism with a finite set of five-dimensional oscillators, a factorization of the dual N-point amplitude with respect to the operators of these oscillators is proposed. A convergent expression for the planar one-loop diagram is obtained. (auth)

17586 (TID-25654) TWO-VARIABLE EXPANSIONS BASED ON THE LORENTZ AND CONFORMAL GROUPS. Winternitz, P. (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Physics). [1970]. 33p. Dep. NTIS.

A review is given of a scattering theory based on two-variable expansions furnished by the Lorentz group. Arguments are given for using the conformal group in such a program, in order to make as much use as possible of relativistic invariance and crossing symmetry simultaneously. (auth)

17587 PARTIAL WAVE METHOD FOR A NONSPHERICAL SCATTERER. Demkov, Yu. N.; Rudakov, V. S. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz.; 59: 2035-47(Dec 1970). (In Russian).

The S-representation for a nonspherical scatterer, which generalizes the ordinary phase shift method for the spherically symmetric problem, is considered. It is shown that for a low incident-particle energy the phase behavior is analogous to that in the spherically symmetric case. The phases can be classified with respect to the azimuthal quantum number l, there being 2l + 1 phases $\eta_l \sim E^{l+1/2}$. For a symmetric scatterer the partial waves and phases can be classified with respect to the symmetry group representations, degeneracy being defined by the dimension of the representation. The Hulthen–Schwinger variational principles, perturbation theory, virial theorem, Neuman–Wigner theorem on nonintersection of $\eta(E)$ curves related to a single representation of the symmetry group are formulated. The Levinson theorem which relates the phase behavior with the number of bound states is discussed. For the case when the scatterer can be represented as a superposition of n zero-range potentials the problem reduces to a purely algebraic problem, to inversion of an n-th-order matrix. The cross section averaged over the directions of the incident wave is expressed as the trace of the matrix in a form convenient for calculations. Some simple examples and resonance cases are considered. The possibilities of applying the method and in particular of applying it to the problem of elastic scattering of electrons by molecules is discussed. (auth)

17588 MODEL OF FIXED SPIN SOURCE SCATTERING. Gostev, V. B.; San'ko, V. A. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; No. 6, 94-7(Nov-Dec 1968). (In Russian).

Integral equations for scattering (in-states) and scattering amplitudes for quantum field model (a generalized Lee model) were obtained by H. Chew (Phys. Rev. 132: 2756(1966)) by introducing pseudoscalar interactions (with fixed particle spin ½). An attempt was made of obtaining an approximate solution for these equations and for determining the properties of scattering amplitudes using a somewhat more complex model or generalizing Lee model by means of pseudoscalar interactions and adding a fixed particle into the Lee model $\nu-\theta$ sector. (R.V.J.)

17589 ELEMENTARY TREATMENT OF RELATIVISTIC CROSS SECTIONS. Terrall, J. R. Amer. J. Phys.; 38: 1460-74(Dec 1970).

It is shown that, when relativity must be taken into account, there is no need to revise the ordinary definition of a cross section. Rather, a slight rearrangement of factors will obtain Lorentz invariant quantities. To demonstrate invariance is quite simple. Next, the reaction rate density can easily be written down just by bringing together, from a particle viewpoint, the various factors one knows on physical grounds should be present. Again, by judicious grouping, the result can be expressed as a product of factors that are separately invariant. The Lorentz transformation of an angular distribution (without explicitly using the Lorentz transformation equations), the relativistic normalization of wave functions, and finally, the connection of this simple approach with S-matrix theory are discussed. (auth)

17590 OPERATORIAL FACTORIZATION AND SYMMETRY OF THE SHAPIRO–VIRASORO MODEL. Yoshimura, M. (Univ. of California, Berkeley). Phys. Lett.; 34B: 79-82(18 Jan 1971).

An operator formalism is presented which exhibits factorization of the nonplanar dual model proposed first by Virasoro and generalized by Shapiro. The model is shown to contain sufficient gauge operators as well as a selection rule in order to eliminate all the ghosts. A further generalization of the model is also suggested. (auth)

17591 THEORY OF KINETIC EQUATIONS IN PRESENCE OF BOUND-STATE PARTICLES. Peletminskii, S. V. (Technical Physics Inst., Kiev). Teor. Mat. Fiz.; 6: 123-41(Jan 1971). (In Russian).

On the basis of formal quantum scattering theory the problems of constructing kinetic equations for particle systems where the formation of the bound states is possible are considered. With the aid of the spatial correlation weakening principle, the chain of integral equations in terms of Moeller scattering operators is deduced. The collision integral for particles in the bound state is found in the main approximation respect to the density. (auth)

17592 CORRECTIONS TO THE EIKONAL APPROXIMATION IN THE QUASI-POTENTIAL APPROACH. Garsevanishvili, V. R.; Goloskokov, S. V.; Matveev, V. A.; Slepchenko, L. A.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 6: 36-41(Jan 1971). (In Russian).

The corrections of the relative order 1/p to the eikonal approximation in the quasi-potential approach are studied. (auth)

17593 SYSTEMATICS OF ELASTIC SCATTERING. Jones, Lorella M.; Ravenhall, D. G. (Univ. of Illinois, Urbana). Phys. Rev., D; 3: 690-5(1 Feb 1971).

A simplification of the crossing matrix for elastic scattering is pointed out. New amplitudes, with particularly simple properties under parity and time reversal, are defined. These are useful in theories where the quantity of interest is the amount of direct-channel helicity flip or sum. For example, in the accompanying paper, this formalism is employed to study suppression of direct-channel helicity flip for Pomeranchukon exchange, as well as other patterns of direct-channel amplitude suppression induced by exchange of particular quantum numbers in the crossed channel. (auth)

17594 REGGE POLE THEORY AND UNITARITY. Obara, Takashi (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 44: 1307-11(Nov 1970).

Under the assumptions that are the case for nonrelativistic theory, it is shown that the Regge pole theory is compatible with unitarity only if the Regge singularities are infinite in number. By merely taking into account a finite number of them, unitarity is justified in restricted regions such as $t \to \infty$ and $s \to s_0$. It is also shown that the double spectral function on which unitarity imposes some restrictions can be constructed by the use of an infinite set of the parallel daughter trajectories. Therefore, introduction of these trajectories can remove the difficulties between the Regge pole theory and unitarity. (auth)

17595 REGGEIZATION OF THE BETHE–SALPETER SCATTERING AMPLITUDES. Matsumoto, Hideki (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 44: 1317-39(Nov 1970).

The Reggeization of the Bethe–Salpeter amplitude is investigated with general kernels. Assuming some integral representations for the interaction kernels and the modified propagator of the scattering particles with unequal masses, a sufficient condition is obtained for the kernels to be of the Hilbert–Schmidt type. Provided that this condition is satisfied, the following is proved, by studying the meromorphy domain of the partial-wave amplitudes: (1) the Sommerfeld–Watson transformation can be performed, (2) the asymptotic behavior of the leading trajectory as $s \to -\infty$ (s: total mass squared) is determined by the rightmost fixed singularity of the kernels, and (3) if the spectral functions of the integral representations are non-negative definite, the derivative of the largest eignvalue $\mu_{Max}(s,l) = \{\lambda_{Min}(s,l)\}^{-1}$ with respect to the angular momentum l is negative for $s < 0$ and $l > -1$, and the leading trajectory is real for $s < 0$ and is nondegenerate. (auth)

17596 ENHANCEMENT OF ACAUSAL EFFECTS BY MULTIPLE SCATTERING. Trueman, T. L. (Brookhaven National Lab., Upton, N. Y.). Nucl. Phys.; B26: 83-103(1971).

The theory of finite electrodynamics due to Lee and Wick predicts small acausal effects. In elementary scattering processes, these effects are too small, by many orders of magnitude, to be detected. A simplified version of this theory, due to Lee and Wick, is applied to multiple coherent scattering processes. The target particles are arranged in various ways—two-particle target; very small, very dense target; many random scatterers; periodic monolayer; three-dimensional periodic array—and the change in the wave packet on passing through the target is calculated. It is found that, in principle, significant enhancement of the acausal effects may be achieved. Unfortunately, the requirements on the target parameters are quite severe and probably met only in dense stars, if anywhere. (auth)

17597 SINGULAR POTENTIALS. Frank, William M. (Naval Ordnance Lab., Silver Spring, Md.); Land, David J.; Spector, Richard M. Rev. Mod. Phys.; 43: 36-98(Jan 1971).

An attempt is made to present a comprehensive review of the literature dealing with singular potentials through March 1969.

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The treatment is confined principally to nonrelativistic quantum mechanics, i.e., to solutions of the partial-wave Schrödinger equation with a singular potential. Some general physical and mathematical properties are given. Exact solutions are presented for those potentials for which they are available. Techniques which have been used in obtaining approximate solutions are outlined. Formal and physical applications of singular potentials are presented. Formal applications are those for which singular potentials have served as mathematical models illustrating concepts in elementary particle physics. These include applications to the Regge pole formalism, quantum field theories, and the peratization approximation. Physical applications entail those which have been made to molecular physics and to high-energy phenomenology. (auth)

17598 RELATIVISITIC QUANTUM MECHANICS OF A MECHANICAL CONTINUUM UNDERLYING THE DUAL AMPLITUDE. Takabayasi, Takehiko (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 44: 1429-30(Nov 1970).

A new formulation of relativistic quantum mechanics of a string is presented. It consists of a unique wave equation which builds in automatically an infinite number of subsidiary conditions to suppress unphysical states. It is shown that the dual amplitude can be derived on the basis of this formalism. (L.B.S.)

17599 IMPACT PARAMETER AMPLITUDE WITH A DIRECT-CHANNEL REGGE POLE. Adachi, Toshimi (Tokyo Metropolitan Tech. Coll.). Progr. Theor. Phys. (Kyoto); 44: 1425-7 (Nov 1970).

The problem of incorporating direct-channel resonances in the impact-parameter formalism in the high-energy region is considered. Using previous results (T. Adachi, Prog. Theor. Phys., 562: 44(1970)), it is shown that the resonances appear in the part A(k,B) of H(k,B). When the impact-parameter amplitude A(k,B) is approximated by a direct-channel Regge trajectory, a high-energy approximation of A(k,B) yields a small-angle diffraction peak. The high-energy behavior of the Regge trajectory is also discussed. (L.B.S.)

17600 INTRODUCTION TO MULTIPLE ASYMPTOTIC SERIES WITH AN APPLICATION TO ELASTIC SCATTERING. Shere, Kenneth D. (Univ. of Nebraska, Lincoln). J. Math. Phys. (N. Y.); 12: 78-82 (Jan 1971).

The concept of asymptotic power series is extended to multiple series of the form $\Sigma_{m=0}^{\infty}\Sigma_{n=0}^{\infty}a_{m,n}x^{-n}e^{-\lambda mx}$. This theory is then applied to elastic scattering from the Yukawa potential. An asymptotic series for the solution at large distances is obtained which is valid for arbitrary wave number and angular momentum. (auth)

17601 PROBABILISTIC INTERPRETATION OF THE CLASSICAL SCATTERING CROSS SECTION. Babbitt, Donald G. (Univ. of California, Los Angeles). J. Math. Phys. (N. Y.); 12: 53-7(Jan 1971).

The probabilistic interpretation of the classical scattering cross section is discussed in a mathematically rigorous framework. In particular, extensive use is made of the notion of a Poisson process based on a plane and on a sphere. The case of Rutherford scattering is given as a detailed illustration. (auth)

17602 NORMALIZATION OF CERTAIN HIGHER-ORDER PHASE-INTEGRAL APPROXIMATIONS FOR WAVEFUNCTIONS OF BOUND STATES IN A POTENTIAL WELL. Yngve, Staffan (Uppsala Univ.). J. Math. Phys. (N. Y.); 12: 114-17(Jan 1971).

Furry has given a formula for the normalization integral of a physically acceptable solution of the time-independent 1-dimensional Schrödinger equation corresponding to a bound state. Considering the wavefunction of a bound state in a single-well potential and using Furry's formula and the connection formulas discussed by N. Fröman, the normalization factor is derived for the higher-order phase-integral approximations introduced earlier by N. Fröman. For the special case of the first-order JWKB approximation, the approximate normalization factor thus obtained is equivalent to that given by Pauli and Furry. (auth)

17603 INCREASING ORDER OF SCATTERING AMPLITUDES IN LOCAL QUANTUM FIELD THEORY. Tran hu'u, Phat (Univ. de Hanoi, Viet-Nam). Acta Phys. Pol.; B1: 323-29(Oct-Dec 1970). (In French).

It is shown that it is possible to obtain the theorems of Greenberg and Low, Froissart, etc. in a theory of quantized fields, in which the principle of causality can be modified. This means that the experimental verification of these theorems can give no information on the validity of the fundamental principles for high energies. (tr-auth)

Particle Accelerators

Refer also to abstracts 15702–15704, 15903, 17351, 17443, and 18178.

17604 (AD-711587) REPORT OF LINAC OPERATION: JANUARY 1–JUNE 30, 1970. Interim Report No. 10. (Naval Research Lab., Washington, D. C.). Aug 1970. 26p. (NRL-MR-2158). NTIS.

The operation and use of the NRL 60-MeV Electron Linear Accelerator is described for the period 1 January–30 June 1970. Progress on the research program is discussed, including 180 degree electron scattering on H and He isotopes, photonuclear excitation studies of 11B and 13C, and neutron resonance spin determinations for isotopes. Installation of various interface electronics completes a computer data acquisition system insofar as the neutron time-of-flight experiments are concerned, and preliminary data with the system have been taken. Total manned time for the period was 1955 hours, divided into 1320 hours for beam and set-up time (including 83 hours for outside users), 612 hours devoted to maintenance and improvements, and 23 hours lost to breakdowns, a record low that will be difficult to beat. References are included, as are brief descriptions of the use of the linac by other groups. (auth) (USGRDR)

17605 (CEA-N-1286) STUDY OF GEOMETRICAL ABERRATIONS OF QUADRUPOLAR LENSES IN GUIDING DEVICES OR FINITE-EMITTANCE BEAM-MATCHING SYSTEMS. APPLICATION TO THE STUDY OF A MATCHING TRIPLET. Tanguy, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1970. 66p. (In French). Dep. NTIS (U. S. Sales Only).

It is shown that from a knowledge of the transfer matrix and aberrations coefficients of a quadrupole lens system, and the four-dimensional beam emittance at the entrance of the lens system, it is possible to obtain all the characteristic beam properties (beam cross section, density in the real plane, density in phase planes, etc.) at the end of the system. Quantitative results are given in relation to aberrations effects in matching system devices. (auth) (France)

17606 (CERN-Trans-70-10) PRIMING AND MEASUREMENT OF COHERENT BETATRON OSCILLATION OF A BEAM DURING THE INITIAL PHASE OF ACCELERATION. Andreichuk, V. N.; Assev, A. A.; Zaitsev, V. I.; Myae, E. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by M. Besroukoff (CERN, Geneva, Switzerland), from report IFVE-SKU-70-6. 12p. (In French). Dep. NTIS (U. S. Sales Only).

For priming the betatron oscillations, a modulator is described and shown schematically. An oscillogram of the signal obtained from the primed betatron oscillations is shown, and results of measurements of the natural behavior of the betatron oscillation frequency at the beginning of the acceleration are plotted. Also shown are curves for the frequency of the radial betatron oscillations with and without correction. (J.F.P.)

17607 (JINR-P9-5285) ELECTRONUCLEAR METHOD OF NEUTRON GENERATION AND FISSILE MATERIAL PRODUCTION. Vasil'kov, R. G.; Gol'danskii, V. I.; Dzhelepov, V. P.; Dmitrievskii, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 21p. (In Russian). Dep. NTIS (U. S. Sales Only).

The possibility of applying the electronuclear method of free-neutron production to nuclear power technology is considered from the most general standpoint. The method is based on the fact that heavy atomic nuclei emit many neutrons when absorbing protons (deuterons) accelerated to high energies. A brief review of the relevant experimental evidence, concerning neutron emission by highly excited nuclei and electron multiplication in targets, is given; and some known designs of electronuclear facilities based on proton and/or deuteron accelerators with beam powers up to 100 MW are discussed. The main difficulties in developing high-current accelerating systems, capable of providing currents sufficiently large (~0.1 A at energies of the order of 1 GeV) for the electronuclear method, are briefly analyzed. Speculation about inherent features of such electronuclear reactors and/or neutron generators is presented, and their possible role for applied and scientific purposes as well as their use in conjunction with ordinary nuclear reactors (in particular, fast breeders) is discussed. (auth)

17608 (JINR-P9-5488) PROGRESS IN CREATION OF THE ACCELERATING SECTION OF A RINGOTRON (KOLSTETRON). Anishchenko, N. G.; Balalykin, N. I.; Vasil'ev, V. A.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

Some questions connected with the creation of the cryogenic high-frequency accelerating system of a ringotron are considered. The data on the behavior of the superconducting layer of cavities in the external magnetic fields of 20 kG are presented, and equipment for producing the layers is described. Data on superconducting solenoids are given as well as the scheme of the system

of the sections. The problems of energy supply for solenoids and energy evacuation are discussed. (auth)

17609 (KFK-1262) KARLSRUHE POLARIZED ION SOURCE. Bechtold, V.; Brueckmann, H.; Finken, D.; Friedrich, L.; Hamdi, K.; Seitz, E.; Ziegler, P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Aug 1970. 8p. (CONF-700811-13). Dep. NTIS (U. S. Sales Only).

From 3rd International Symposium on Polarization Phenomena in Nuclear Reactions, Madison, Wis.

The investigation of different charge exchange reactions shows that positively charged polarized hydrogen ion beams can be produced with a Lamb shift type ion source. The special features of the Karlsruhe polarized Lamb shift type ion source C-LASKA which is designed for operation at the Karlsruhe isochronous cyclotron are discussed. Beams of negatively charged polarized deuterium ions have been obtained with high beam qualities and the source C-LASKA will deliver polarized deuteron beams for injection into the cyclotron with an intensity of the order of 1 μA at an emittance of 1 cm Rad $\sqrt{eV}$. (auth)

17610 (KFK-1265) ENERGY DEPENDENCE OF CHARGE EXCHANGE REACTIONS FAVOURABLY USED IN LAMBSHIFT TYPE ION SOURCES. Bechtold, V.; Brueckmann, H.; Finken, D.; Friedrich, L.; Hamdi, K.; Seitz, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Aug 1970. 5p. Dep. NTIS (U. S. Sales Only).

Iodine and argon can be favorably used in Lambshift type ion sources for selective ionization by charge exchange collisions. The energy dependence of the selectivity of these charge exchange collisions has been measured by investigating the quenching effect and the nuclear tensor polarization. Both reactions show with increasing energy the same monotonous decrease of the selectivity. For production of polarized deuterons at optimum conditions a Lamb-shift ion source is to be operated below 1 keV beam energy. (auth)

17611 (LA-4474) STOPPED MUON CHANNEL FOR LAMPF. Hughes, V. W.; Ohnuma, S.; Tanabe, K.; Thompson, P.; Vogel, H. F. (Los Alamos Scientific Lab., N. Mex.). May 1970. Contract W-7405-eng-36. 38p. Dep. NTIS.

The design of the Stopped Muon Channel for LAMPF is discussed in detail, including the characteristics of the output beams with regard to intensity, emittance, polarization, and beam purity. The channel consists of a pion collection and bending portion, an alternating gradient quadrupole portion to capture decay muons, and a final magnetic analyzer portion to provide a pure muon beam. Alternative designs are considered, but none has been found to be preferable to the proposed design. (auth)

17612 (LA-tr-71-2) HIGH ENERGY AND HIGH RESOLUTION SPECTROMETRY USING THE BEAM OF THE SATURNE SYNCHROTRON. Thirion, Jacques; Birien, Paul; Saudinos, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Los Alamos Scientific Lab., N. Mex., from report CEA-N-1248. 74p. Dep. NTIS.

An abstract of this paper, prepared from the original language appeared as NSA 24: 15705.

17613 (LYCEN-7055) THE INTERDIGITAL H-TYPE (IH) STRUCTURE, AN ACCELERATING STRUCTURE FOR LOW ENERGY BEAMS. Bres, M.; Chabert, A.; Foret, F.; Tran, D. T.; Voisin, G. (Lyon Univ., France. Institut de Physique Nucleaire). Jul 1970. 35p. Dep. NTIS (U. S. Sales Only).

A brief description of the structure is given; its principal characteristics, which have been deduced from a series of experiments, are discussed from a theoretical point of view. Its practical use in an accelerator is considered and the Lyon heavy-ion linear accelerator project is used as an illustration. (auth) (France)

17614 (SLAC-Trans-127) STRUCTURE OF ELECTRON BUNCHES FROM AN INJECTOR WITH STEPPED VARIATION OF THE WAVE PHASE VELOCITY. Vishnyakov, V. A.; Grishaev, I. A.; Grizhko, V. M.; Kolosov, V. I.; Krasnikov, V. D.; Mel'nichenko, V. V.; Fursov, G. L. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Stanford Linear Accelerator Center, Calif., from report KHFTI-70-17. 11p. Dep. NTIS.

Calculations and experimental data on the structure of bunches produced by an injecting section with a step change in the phase velocity of the wave are reported. It is shown that the output parameters of the 2 GeV electron linac can be improved by using an injector with a step change in the phase velocity of the wave. (auth)

17615 (SLAC-Trans-128) PROBLEMS OF BEAM OPTICS IN A MULTISECTION 2-GeV ELECTRON LINAC. Grishaev, I. A.; Gugel, I. N.; Dovbnya, A. N.; Kolot, Z. M.; Kornienko, E. V.; Mocheshnikov, N. I.; Perrenko, V. V. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Stanford Linear Accelerator Center, Calif., from report KHFTI-70-18. 29p. Dep. NTIS.

The influence of transverse high-frequency fields on the properties of the accelerating channel and on the beam emittance as a function of the phase width of a bunch is discussed. It is shown that a linear accelerator is capable of particle phase separations, as a result of which the trajectories of particles with different phases are separated in space and the effective output emittance is much greater than the ideal value. Possible methods of using this property to shorten the phase length of a bunch are discussed. The effect of phase fluctuations on the extracted-beam parameters is examined, including the emittance in different planes, the energy spectra, and the angular and radial distributions. A method of producing short relativistic electron bunches is described. In this method high-frequency transverse fields produce a coupling between the particle phase and its radial-angular characteristics, and this is then used to produce nonisochronous motion of the particles in a longitudinal magnetic field (solenoid) or a quadrupole channel (strongly focusing system of the FD type). The discussed problems have been investigated numerically using a model and the M-220A digital computer and the MN-7M analog computer. The "Emittance" program is described. (auth)

17616 (TRI-70-3) CONCEPTUAL DESIGN OF THE INJECTION SYSTEM FOR A 500 MeV H^- CYCLOTRON. Fredriksson, O. K.; Meads, P. F.; Smith, I. L.; Younger, F. C. (TRI-Univ. Meson Facility, Vancouver (British Columbia)). May 1970. 44p. Dep. NTIS (U. S. Sales Only).

A conceptual design for a negative hydrogen ion injection system for the TRIUMF negative ion cyclotron is presented. This system provides ions at an energy of 300 keV in pulses of suitable duration and frequency for acceleration by the cyclotron. Average beam currents in excess of 1000 μA are expected when pulses of 7 nsec are injected. Peak intensities of up to 10 mA are expected for pulses of less than 1 nsec. The design incorporates an Ehlers type ion source held at a 300 keV potential by a very well-regulated Cockcroft-Walton rectifier. The accelerated ions are transported in a system utilizing electrostatic quadrupoles and achromatic bending systems to maintain the time structure of the beam pulses. Chopping and bunching are controlled at cyclotron frequency. The phase angle is adjusted for the correct beam arrival at the cyclotron accelerating gap. The beam is transported from a separate ion source room over the top of the cyclotron shielding and then down the axis of the cyclotron to the inflector near the cyclotron median plane. Stray fields of over 40 G are expected. Magnetic shielding will be required. (auth)

17617 INVESTIGATION OF SECONDARY CHARGED PARTICLE EFFECTS ON PROTON BEAMS IN BETATRON REGIME. Dimov, G. I.; Dudnikov, V. G.; Shamovskii, V. G. At. Energ. (USSR); 29: 356-61(Nov 1970). (In Russian).

The interaction of proton beams of 1 MeV in accelerator rings with secondary charged particles formed by the ionization of the residual gas is investigated. The space charge of low intensity proton beams is fully compensated with electrons. At current increases the coherent oscillations, which cause the relaxation oscillations of space-charge density, arise. In high intensity beams, the coherent oscillations arise before the proton beam vertical dump. (auth)

17618 NUMERICAL CALCULATION OF ABSOLUTE FORWARD THICK-TARGET BREMSSTRAHLUNG SPECTRA. Ferdinande, H.; Knuyt, G.; Van de Vijver, R.; Jacobs, R. (Rijksuniversiteit, Ghent). Nucl. Instrum. Methods; 91: 135-40 (1971).

A method is presented to obtain a simple analytical expression from which one can calculate numerically the absolute forward thick-target bremsstrahlung spectrum produced by electrons in the energy range from 1 to about 25 MeV. In penetrating the target, multiple scattering or diffusion and energy loss of the electrons together with attenuation of the created gamma-ray beam occur and all these phenomena are taken into account. Comparison with experimental results for 1 to 21 MeV electrons incident on low and high Z-, intermediate and thick targets, shows a remarkably good agreement in magnitude and shape. The overall accuracy of the results is estimated to be of the order of 20%. (auth)

17619 MAGNET-SPARK-CHAMBER SYSTEM USED IN AN EXPERIMENT ON (p,2p) REACTIONS AT 600 MeV. Fagerstroem, B. (Univ. of Uppsala); Johansson, A.; Tibell, G.; (and others). Nucl. Instrum. Methods; 91: 125-33(1971).

An account is given of the experimental apparatus used in a study of (p,2p) reactions at 600 MeV. Particular emphasis

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is placed on the evaluation of the momenta from the spark chamber coordinates and from the magnetic field. A discussion on various error sources is given. (auth)

17620 DIFFERENTIALLY PUMPED GAS TARGET. Bussiere, J.; Robson, J. M. (Univ. of Ottawa). Nucl. Instrum. Methods; 91: 103-7(1971).

A differentially pumped gas target is described in which the gas is localized in a central region of one inch length. Advantage is taken of the supersonic jet created by the emerging gas to obtain a high pressure gradient outside this region. (auth)

17621 GAMMA FLASH SUPPRESSION FOR THE ORELA PULSED NEUTRON SOURCE. Macklin, R. L. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 91: 79-84(1971).

A gamma ray flash suppression system for neutron time-of-flight experiments at the Oak Ridge Electron Linear Accelerator (ORELA) has been found very effective for partial cross section measurements. For capture cross section measurements at 40 m the residual pileup flash pulse from a typical sample is well within the neutron binding energy range, where the detector response is linear. This has allowed two parameter (time and pulse height) analysis down to 0.5 μsec after the flash. (auth)

17622 CALCULATION OF THE LONG-LIVED INDUCED ACTIVITY IN THE SOIL AROUND HIGH-ENERGY ACCELERATOR TARGET AREAS. Gabriel, T. A. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 91: 67-72(1971).

Nucleon-meson cascade calculations have been carried out and estimates of the induced activity in the soil surrounding high-energy accelerator target areas have been obtained. Results on the contribution to the induced activity from various residual nuclei are presented for a specific irradiation time and as a function of time after beam shutdown for a 3-GeV proton accelerator. (auth)

17623 ULTRA-HIGH RESOLUTION SPECTROMETER SYSTEM FOR CHARGED PARTICLE STUDIES OF NUCLEI. Blosser, H. G.; Crawley, G. M.; Deforest, R.; Kashy, E.; Wildenthal, B. H. (Michigan State Univ., East Lansing). Nucl. Instrum. Methods; 91: 61-5(1971).

An arrangement for introducing feedback into a charged particle magnetic analysis system for nuclear reaction studies is described. In initial tests of the system, a resolution of 5 keV has been obtained in (p,p′) studies at 30 MeV with 70% of the cyclotron internal beam on target. This corresponds to a resolving power $p/\Delta p$ of 12,000. Essential features of the system, in addition to the feedback, are a careful definition of the cyclotron source by means of internal slits and the use of dispersion matching to cancel the effect of coherent on-target energy spread. (auth)

17624 SINGLE-DIFFERENCE BREMSSTRAHLUNG UNFOLDING TECHNIQUE FOR THE MEASUREMENT OF HIGH ENERGY PHOTONUCLEAR CROSS SECTIONS. Matthews, J. L.; Owens, R. O. (Univ. of Glasgow). Nucl. Instrum. Methods; 91: 37-43(1971).

A new method for obtaining photonuclear cross sections from bremsstrahlung yield data is described and compared with the conventional unfolding techniques. This single-difference method, which is intended for experiments in the 40 to 130 MeV photon energy range, uses two bremsstrahlung radiators of different atomic number, viz. Be and Al. A high energy peak is produced in the difference photon spectrum by virtue of the different electron energy losses in the two radiators, whilst the weak Z-dependence of the bremsstrahlung spectrum alloys near cancellation of the intensity at low photon energies. For the measurements in question the new method is shown to be superior to other techniques. (auth)

17625 APPARATUS FOR CHANNELING EXPERIMENTS. Gemmell, D. S.; Worthington, J. N. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 91: 15-28(1971).

A description is given of an apparatus for use in measurements on channeling and related effects seen in the passage of charged particles through single crystals. The system features good angular resolution, suitability of use for many different types of experiment and computer control of the goniometer and detector motions as well as of the data acquisition and analysis. Some examples of data recorded with the system are presented. (auth)

17626 TARGET ASSEMBLY FOR LOW YIELD NEUTRON AND GAMMA-RAY EXPERIMENTS. Robb, A. D.; Schier, W. A. (Univ. of Virginia, Charlottesville). Nucl. Instrum. Methods; 91: 13-14(1971).

A simply designed target assembly for low yield neutron and gamma-ray experiments which require close target to detector geometries is described. The assembly allows one to measure a full angular distribution to back angles of approximately 170° with a minimum of wall material between the target and the detector at all angles. The beam spot at the target position can be readily monitored with a closed circuit TV for accurate remote focusing and positioning. (auth)

17627 FLOW SYSTEM FOR THE CONTINUOUS ACTIVATION OF GASEOUS OR LIQUID SAMPLES PARTICULARLY FOR AN ELECTRON ACCELERATOR. Filss, P.; Guldbakke, S.; Nolte, G.; Tietze, K. (Physikalisch-Technische Bundesanstalt, Brunswick). Nucl. Instrum. Methods; 91: 1-4(1971). (In German).

A flow system for the activation of gaseous or liquid samples is described for the optimal use of the radiation source giving good counting geometry. Choosing a transport time of appr. $^3/_4$ of the half life of the investigated nuclide makes the measured decay rate independent of flow velocity. The determination of photonuclear cross sections needing high accuracy of measurement is possible. The radiation source used was the bremsstrahlung beam of an electron synchrotron. An absorbed dose rate of 1000 rd/min continuously produces a concentration of activity of 1 μCi/ml in distilled water. (auth)

17628 300 GeV DESIGN. CERN Cour.; 11: 3-8(Jan 1971).

The design of the proposed CERN 300-GeV proton synchrotron as decided by the "300 GeV Machine Committee" is outlined. The main parameters are listed. (W.H.K.)

17629 FAST RABBIT SYSTEM FOR NEUTRON GENERATORS. Schramel, P. (Gesellschaft fuer Strahlenforschung mbH, Neuherberg, Ger.). Kerntechnik; 12: 373-6(Sep 1970).

The design of a pneumatic target transport system for a Van de Graaff 14-MeV neutron irradiation facility is described. The rabbit facility has a transport time of about 100 ms for determining short-lived activities. The facility was designed for the determination of oxygen by neutron activation analysis. (W.H.K.)

17630 PRESENT STATE OF THE PHYSICS AND TECHNOLOGY OF ACCELERATION. Alikhan'yan, A. I.; Kheifets, S. A. (Erevan Physics Inst.). Usp. Fiz. Nauk; 101: 218-48(Jun 1970). (In Russian).

This review is divided into two main parts. One deals with traditional methods of acceleration, and the other deals with new methods. The section under traditional methods notes recent improvements and operating characteristics of proton and electron synchrotrons in various parts of the world including machines at Geneva, Saclay, Dubna, Moscow, Serpukhov, Argonne, Brookhaven, Berkeley, Princeton, Erevan, Tomsk, Tokyo, Cornell, etc. Planned additions are described. There are listings of linear accelerators, phasotrons, relativistic cyclotrons, and monoenergetic cyclotrons. The characteristics of electron, positron, and proton accumulators are listed. Under new methods, acceleration is accomplished by the use of the collective fields of a plasma, the use of superconducting magnets and resonators at low temperatures, and the use of computers to control the parameters of an accelerating system. (132 references.) (TTT)

17631 INFLUENCE OF SPACE CHARGE ON STABILITY OF BETATRON OSCILLATIONS IN CYCLIC ACCELERATORS. Kolomenskii, A. A.; Polukhin, A. T. At. Energ. (USSR); 29: 352-6(Nov 1970). (In Russian).

A theoretical investigation is presented concerning the influence of accelerated beam space charge on betatron oscillation stability in the vicinity of the parametric and combination resonances. The corresponding self-consistent equations are solved approximately by means of the asymptotic averaging method. The criteria are found for estimation of the value of the permissible space charge. It is shown that this charge can lead not only to increasing, but also to decreasing betatron amplitudes. The specific instability is investigated which can arise due to coupling between transverse and longitudinal oscillations through the space charge. (auth)

17632 1.2 MeV HIGH-CURRENT PROTON ACCELERATOR. Abramyan, E. A.; Brovin, M. M.; Vecheslavov, V. V.; (and others). At. Energ. (USSR); 29: 346-51(Nov 1970). (In Russian).

The peculiarities of calculation and design of an experimental transformer-type proton accelerator are described. The ion source with electromagnetic oscillation of electrons and accelerating tube with electrostatic quadrupole lenses are used for forming and transporting the proton beam. The main purpose of developing the accelerator was a verification of designing ideas and applicability of calculating methods for producing high-current proton beams. A 1.2 MeV proton beam with maximum and average currents of about 80 and 9 mA, respectively, was obtained (pulse duration at pulse rate 50 cps). There is satisfactory agreement between calculated and experimental values of the main parameters. The results of this work may be used for the design of high-current proton injectors or industrial devices. (auth)

17633 GEOMETRY OF THE ORBITS IN SECTOR-TYPE CYCLOTRONS. Moroz, E. M. This paper was summarized in

At. Energ. (USSR); 28: 142-3(Feb 1970) as paper No. 369/5277. (In Russian).

Geometrical relationships between the elements of the orbit in a sector cyclotron with a stepped field are derived. (W.H.K.)

17634 METHOD OF CALCULATING THE ION TRAJECTORIES IN A RADIAL-SECTOR STEP-FIELD CYCLOTRON. Moroz, E. M. This paper was summarized in At. Energ. (USSR); 28: 143(Feb 1970) as paper No. 370/5345. (In Russian).

Recurrence formulas are given for the trajectory calculation. The calculation assumes a stepped magnetic field of the sector-cyclotron type, radial boundaries of sectors and dees, the accelerating gaps are negligibly narrow, and the increase of particle energy in the accelerating gap is phase independent. (W.H.K.)

17635 BEAM POSITION STABILIZATION SYSTEM FOR THE VAN DE GRAAFF ACCELERATOR LECH. Bienkowski, Andzhsei (Univ., Warsaw). Nukleonika; 15: 285-90(1970). (In Russian).

A beam position stabilization system in the switching magnet exit slits is described. A good beam position stability at the target is obtained with the stability of the switching magnet power supply of ±1.5%. (auth)

17636 STABILIZATION OF THE TRANSVERSE COHERENT RESISTANCE INSTABILITY BY AUTOMATIC CORRECTION. Roginskii, L. A. This paper was summarized in At. Energ. (USSR); 28: 143-4(Feb 1970) as paper No. 371/5376. (Ir Russian).

The dispersion equations for the beam eigenfrequencies are obtained by the solution of the linearized kinetic equation for the particle distribution function. The transfer coefficients of the dispersion equation are then chosen to stabilize the transverse coherent resistance instability. Landau damping is taken into account. (W.H.K.)

17637 PRODUCTION OF MULTIPLY CHARGED IONS IN GAS-DISCHARGE ION SOURCES. Krupp, H. (Univ., Heidelberg). Nucl. Instrum. Methods; 90: 167-72(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

The two contrary processes of multiply charged ion production and their possible superpositions that take place in gas-discharge ion sources are described. Three different types of ion sources are compared, each of which is inherently related to one of these production processes in regard to its discharge parameters. Investigations have shown that by variation of the geometry, the gas pressure, and the magnetic field strength, particular sets of discharge parameters can be found under which reasonable currents of the desired multiply charged ion are obtained. The problem of ion-source design is considered under the aspects of lifetime and performance. (auth)

17638 UNIVERSITY OF TOLEDO BEAM–FOIL FACILITY. Schectman, R. M.; Curtis, L. J.; Strecker, C.; Kormanyos, K. (Univ. of Toledo). Nucl. Instrum. Methods; 90: 197-201(1970).

From 2nd International Conference on Beam–Foil Spectroscopy, Lysekil, Sweden. See CONF-700634.

The facility for experimental work in beam–foil spectroscopy being developed at The University of Toledo is described. Novel features include: 1. Provisions for optically scanning the ion beam and automatically recording the data so obtained in a multichannel analyzer. Scanning is accomplished by moving a collimating lens and mirror parallel to the beam with constant velocity. The collimated beam is subsequently focused on the entrance slit of a Perkin Elmer f/4.5 grating monochromator. Single photons are detected and pulses are recorded in a multiscaler synchronized with the beam scanner. 2. A facility for making charge-state identification of spectral lines, using a technique compatible with the geometry employed for mean-life measurements, is being constructed. A set of parallel electric field plates can be raised in the observation chamber to beam level through vacuum feedthroughs and a transverse electric field applied. Light from the beam is observed through a slit located a distance L downstream along the plate and spectral wavelengths are determined for both directions of the applied electric field E. The net transverse Doppler shift induced can easily be seen to be $\Delta\lambda/\lambda = Z \cdot 2eEL/(2mc^2T)^{\frac{1}{2}}$, where T and mc^2 are the kinetic and rest energies of the ion beam, respectively. Introduction of representative parameters shows that a shift of 2 Å/unit charge is easily attainable. 3. Use of nanosecond pulsed-beam time-of-flight techniques to measure the energy of the ion beam after it emerges from the foil. This technique has been in routine use in nuclear physics experiments, and its extension to these applications is described. (auth)

17639 CERN–IHEP BOSON SPECTROMETER. A TECHNICAL DESCRIPTION. Baud, R.; Benz, H.; Blumenfeld, H.; (and others). pp 557-79 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

Design modifications of the CERN–IHEP Boson Spectrometer (CBS) at the Serpukhov Synchrotron are described. The CBS is a missing-mass spectrometer and is used to study to X^- decay in the $\pi^- + p \rightarrow p + X^-$ interaction. (W.H.K.)

17640 MULTIPARTICLE SPECTROMETER SYSTEM FOR THE 10 TO 30 GeV/c REGION. Ficenec, J. R. (Virginia Polytechnic Inst., Blacksburg); Clifford, T. S.; Schreiner, W. M.; (and others). pp 581-92 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

The system is designed to initially study multiparticle production in p + p interactions at 28.5 MeV/c. The system consists of three spectrometers and a PDP-9 computer connected via the Brooknet data link to the CDC-6600 computer. The spectrometer is described and some meson experiments that can be performed using the device are indicated. (W.H.K.)

17641 MULTIPARTICLE MAGNETIC SPECTROMETER SYSTEMS WITH ELECTRONIC DIGITIZED DETECTORS AND ON-LINE COMPUTER. Lindenbaum, S. J. (Brookhaven National Lab., Upton, N. Y.). pp 609-39 of Experimental Meson Spectroscopy. /Baltay, Charles (ed.). New York; Columbia Univ. Press (1970).

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa. See CONF-700525.

The present status and future plans for the digitized detector MK I Double Vee Magnetic Spectrometer system at BNL are reviewed. The detector layout and data handling system, resolution, and interaction that can be investigated are discussed. (W.H.K.)

17642 USES OF CYCLOTRONS IN CHEMISTRY, METALLURGY, AND BIOLOGY. Proceedings of Conference Held at Oxford, 22–23 September 1969. Amphlett, C. B. (ed.). London; Butterworth and Company Ltd. (1970). 409p. 250s. (CONF-690924).

Available from Daniel Davey and Company, Inc., Hartford, Conn.

Thirty four papers were presented at the conference. A separate abstract was prepared for each. (UK)

For abstracts of individual papers see: 15554–15557, 15648, 15700–15704, 15717, 15912, 16042, 16043, 16188, 16387, 16557, 16558, 16619, 17643–17651, 17738, 17824, 17927–17929, and 18018.

17643 APPARATUS FOR THE PROTON IRRADIATION OF SUPERCRITICAL WATER IN A FLOW SYSTEM. Marsh, W. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 101-16 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

An apparatus is described for the irradiation of water at pressures up to 400 bar (6000 psi) and temperatures up to 600°C by high-energy protons from the Harwell Variable Energy Cyclotron. The irradiation vessel is a pressure vessel fabricated from Nimonic 80A alloy, one end of which is thinner than the normal wall thickness and acts as a window for the particle beam. Irradiation is carried out with ~45 MeV protons, which penetrate the end window and emerge with a mean energy of ~7 MeV. The sampling system allows a measured volume to be delivered into a conventional gas-handling vacuum apparatus with minimal disturbance to flow. Dissolved product gases are measured by gas chromatography. At a steady current, steady concentrations of products, dependent on flow-rate and production G value, were obtained. Under supercritical conditions the low dielectric constant (<10) might be expected to lead to high concentrations of reactive intermediate species near the track center, resulting in higher molecular yields. The net yields of hydrogen measured with pure water (G = ~5) in preliminary experiments were higher than at room temperature, but could be suppressed to negligible values by small concentrations of oxygen and ammonia ($<5 \times 10^{-2}$M), suggesting that fast back reactions occur at the high temperatures. (UK)

17644 INITIAL EXPERIENCE WITH A 30-in ISOCHRONOUS CYCLOTRON FOR MEDICAL USE. Tilbury, R. S.; Mamacos, J. P.; Laughlin, J. S. (Sloan-Kettering Inst. for Cancer Research, New York). pp 117-24 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in

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Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

Several methods were developed for the production of radionuclides using a 30 in. diam. isochronous cyclotron at the Sloan–Kettering Institute for Cancer Research. The radionuclides were converted into radiochemicals or radiopharmaceuticals for use in research and diagnosis of cancer. Alternative reactions were investigated for the production of ^{18}F, ^{123}I, ^{121}I, ^{52}Fe, ^{11}C, and other radionuclides. Methods of production and chemical processing of radioactive gases, O_2, N_2, CO, and CO_2 labelled with ^{15}O, ^{13}N, and ^{11}C, were developed. Target chambers for the irradiation of gases, solids, and liquids were designed and constructed. The liquid target chamber used for ^{18}F production contained 10 ml of water, was constructed mainly of titanium, and provided a catalyst chamber for the recombination of hydrogen and oxygen radiolytic gases. The solid target chamber used for the production of ^{52}Fe, ^{48}Cr, and the irradiation of any solid material in vacuo was water cooled to withstand >50 μA beam current. The gas target chambers were designed for the irradiation of gases or gaseous mixtures, or for the irradiation of solids (e.g., charcoal, boric oxide, tellurium metal) in a gas stream. An internal target probe was designed and constructed with efficient water cooling for the irradiation of solids inside the vacuum chamber of the cyclotron, to take advantage of the higher beam currents available and of the variation of particle energy with radius. (auth) (UK)

17645 RADIOISOTOPE PRODUCTION IN THE I.Ph.P.E. CYCLOTRON. Krasnov, N. N.; Dmitriev, P. P.; Konstantinov, I. O.; (and others) (Inst. of Physics and Power Engineering, Obninsk, USSR). pp 159–67 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The main problems of radioisotope production on the cyclotron are considered and operational data for isotope production in the cyclotron are presented. Three types of targets used for the bombardment of different materials by the cyclotron beam are described. Data are given on the isotope yields for 40 isotopes produced on the I.Ph.P.E. cyclotron. (auth) (UK)

17646 MINIMUM CYCLOTRON SIZE FOR RADIATION THERAPY: A STUDY OF RELEVANT PHYSICAL PARAMETERS. Goodman, Leon J. (Columbia Univ., Upton, N. Y.); Marino, Stephen A.; Brennan, James T. Contract AT-(30-1)-2740. pp 209–24 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The use of the reaction $^{9}Be(^{2}H,n)^{10}B$ with cyclotron-generated deuterons was examined with respect to radiotherapy requirements. Improvement in depth dose was required which could only be achieved by increase of energy of the deuteron beam. To obtain the necessary information on the cyclotron magnet diameter required experiments simulating realistic therapy conditions were performed within the last year at the Texas A and M Variable Energy Cyclotron (TAMVEC). Collimated beams of neutrons were generated by deuterons of various energies bombarding thick and thin beryllium targets. Dose rate, depth dose and secondary particle build-up measurements were made using a tissue-equivalent ionization chamber in a large tissue phantom. These studies show the minimum deuteron energy required to be ~30 MeV to satisfy the criterion of 50% depth dose at a minimum depth of 10 cm of tissue. The thin-target investigations demonstrated that depth dose can be increased somewhat if thin targets are used. (UK)

17647 TECHNIQUES USED IN ON-LINE FISSION EXPERIMENTS WITH THE V.E.C. Croall, I. F.; Cunninghame, J. G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 225–31 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

Techniques currently in use on the Harwell Variable Energy Cyclotron for on-line fission studies are discussed. Methods of target preparation and thickness measurement are described. Pulse-height measurements and preliminary data processing use a PDP-8 computer programmed to act as an associative storage analyzer. Investigations carried out using these techniques include the effects of increasing incident particle energy on the proton-induced fission of ^{232}Th, and the effects of angular momentum on the fission of the compound nucleus ^{210}Po. (auth) (UK)

17648 ON-LINE NUCLEAR SPECTROSCOPY OF SHORT-LIVED ISOTOPES. Macfarlane, Ronald D. (Texas A and M Univ., College Station. Niels Bohr Inst., Copenhagen); Oakey, Neil S.; Gough, Richard A. pp 232–9 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

Some details of the helium-jet recoil transport method are discussed, particularly with respect to the speed of the system for transporting short-lived radioactive species. Experiments are described where specific hot atom reactions are used to isolate nuclear reaction products. The possible adaptation of the helium-jet recoil transport method for on-line mass separation is also discussed and some results are presented on helium-product separation and product ionization. (auth) (UK)

17649 CYCLOTRON IRRADIATION OF EXTENDED OBJECTS. Dealler, J. F. B.; Ettinger, K. V. (Univ. of Birmingham, Eng.). pp 240–9 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The problems of achieving uniform irradiation of objects which are large in comparison with the size of the cyclotron beam are discussed, and the method of assessing uniformity is described. Techniques of achieving a uniform distribution of radiation over a large specimen placed outside the vacuum system are proposed, based on a method of applying random movements to the target. (auth) (UK)

17650 TARGET SYSTEMS FOR RADIOISOTOPE PRODUCTION ON THE MEDICAL RESEARCH COUNCIL CYCLOTRON. Vonberg, D. D.; Baker, L. C.; Buckingham, P. D.; (and others) (Hammersmith Hospital, London). pp 258–72 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

Target systems used for short-lived radioisotope production on the M.R.C. Cyclotron are described in detail and the factors affecting efficient production discussed. Choice of target material, target cooling, radioisotope recovery, suitable beam energy and target thickness for optimum yield of the required isotope, are all considered. The problems of power dissipation in the internal target using beam currents up to 300 μA are fully discussed. Reasons for using the static "grazing incidence" target in preference to rotary or vibratory target systems are stated and methods of internal target preparation described. Beam extraction through a thin vacuum-retaining foil permits a range of external targets to be bombarded using beams of low power density and also allows the use of energy-degrading foils. A method is described of indicating the external beam distribution during bombardment and details are given of external targets using solid, liquid and gaseous target materials. Recently-developed targets for radioactive gas production are described and typical performance figures quoted. (auth) (UK)

17651 TECHNIQUES AND APPARATUS FOR IRRADIATING METALLURGICAL SPECIMENS ON THE HARWELL VARIABLE ENERGY CYCLOTRON. Worth, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 282–93 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The Harwell Variable Energy Cyclotron has been used in a variety of metallurgical experiments. The build-up of nuclear reaction products that occurs in reactor structural and fuel materials was simulated by implanting inert gas ions in metals and ceramics. Medium energy ions were used to create radiation damage in many different materials to simulate fast neutron damage. Carbon ions were implanted in molybdenum to study the effects of controlled amounts of interstitial impurities. Beams from the cyclotron will also be used to study the mechanism of ion channelling through single crystals. The apparatus and techniques used for these experiments are discussed and methods of obtaining uniform concentrations of implanted ions throughout a volume are described. The factors governing the choice of beams for radiation damage experiments are also discussed. (auth) (UK)

17652 HIGH ENERGY NUCLEAR SPECTROSCOPY PROJECT FOR THE SATURNE SYNCHROTRON. Saudinos, J. (CEA,

Saclay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.98-9(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

A high energy nuclear spectrosccpy project designed by Saclay Nuclear Physics Department is briefly described. An energy resolution about 100 keV with 1 GeV protons is contemplated. (France)

17653 MEASUREMENT OF CYCLOTRON PARAMETERS BY THE METHODS OF OPTICAL SPECTROSCOPY. Trofimov, O. A.; Yushkov, A. V. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 35-41(Mar-Apr 1968). (In Russian).

The possibilities were examined of the measurement of the absolute quantity and the intensity topographies of the high-frequency electric field between the dees, and also the energies of the accelerated ions by the method of optical spectroscopy, based on the electro- and magneto-optical effects (Stark, Doppler, and Wien effects), occurring in the cyclotron. Estimates were made of these effects for different experimental geometries. (tr-auth)

17654 A 40 TO 200 kV ION ACCELERATOR WITH THREE BEAM LINES. Bannenberg, J. G.; Boerboom, A. J. H. (FOM-Insituut voor Atoom- en Molecuulfysika, Amsterdam). Nucl. Instrum. Methods; 91: 269-76(1971).

The accelerator (mass range 1 to 86) consists of a sputtered ion source or a duoplasmatron with extraction electrode, Einzel lens, analyzing magnet, and associated power supplies, mounted inside a metal box at high voltage; a three-cylinder accelerating lens with the last cylinder at ground potential, the central cylinder following a nonlinear relation to the accelerating voltage to focus the beam at the mass-defining diaphragm at a fixed position; and a combination of an electrostatic quadrupole triplet, a second diaphragm, a three-port switch magnet, and another triplet. The two diaphragms make it possible to control beam radius and divergence (max. 1°) independently. (auth)

17655 A CYCLOTRON AS AN INJECTOR AND AS A POST-ACCELERATOR FOR A TANDEM VAN-de-GRAAFF. Boettger, O.; Mahrt, R. (AEG-Telefunken Research Inst., Frankfurt am Main). Nucl. Instrum. Methods; 91: 277-83(1971).

Utilization of a cyclotron in addition to a tandem van de Graaff will greatly enlarge the acceleration potentiality for both light and heavy particles. Energies achievable by series arrangements of a tandem and a cyclotron and vice versa are considered. Details and problems connected with these arrangements, such as external injection into a cyclotron, stripping, bunching, beam transfer, and energy variation are discussed. (auth)

17656 MASS-SEPARATED ION SOURCE. Wilson, R. G.; Jamba, D. M. (Hughes Research Labs., Malibu, Calif.). Nucl. Instrum. Methods; 91: 285-8(1971).

A mass-separated ion source can eliminate the need for large mass separation units in energetic ion beam systems. The performance of a Colutron mass-separated ion source employing a small Wein (E × B) velocity filter as the mass separation element, an Einzel lens for focusing, and a hot-cathode, electron-bombardment ion source was studied. Mass-separation and focusing capabilities were determined by mass spectra and ion image-converter measurements. Emittance and perveance measurements of the total unit were made. The unit was operated with H_2, He, H_2O, Kr, and with BN in a charge holder in an H_2 discharge (to study boron beams). Nearly parallel, μA beams of masses up to about 12 amu and diameters from 3 to 5 mm were well resolved. (auth)

17657 BALANCE FOR USE IN TARGET EVAPORATION CHAMBERS. Chamberlin, E. P. (Texas A and M Univ., College Station). Nucl. Instrum. Methods; 91: 289(1971).

A torque-motor balance for measuring the amount of target material evaporated onto a substrate inside a deposition chamber is described. The readout is analog and is accurate to within 3%. (auth)

17658 INFLUENCE OF THE NATURE AND THE THICKNESS OF TARGETS ON THE PRODUCTION OF BREMSSTRAHLUNG UTILIZABLE FOR ACTIVATION BY (γ,n) REACTIONS. Engelmann, Ch. (CEN, Saclay, France). Nucl. Instrum. Methods; 91: 189-94(1971). (In French).

The effect of the Z of the target and its thickness for Al, Cu, and Pt on (γ,n)-induced activities was determined with silver and carbon activation monitors. The existence of an optimum thickness, apparently independent of Z but a function of the energy of the incident electrons, is deduced. It is also shown that maximum activation with a platinum target is three times as great as that with an aluminum target, and that it does not vary proportionally with the square of the Z of the target. (auth)

17659 NON-LINEARITIES AND ABERRATIONS OF CORPUSCULAR-OPTICAL ELEMENTS. Jung, V. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods; 91: 195-203(1971).

One of the objectives aimed at in corpuscular optics is to deform the phase area of a particle beam on its passage through corpuscular-optical elements only to such an extent that, firstly, the actual area is not increased and, secondly, there is no effective expansion of the phase area as a result of trail formation caused by nonlinearities. Thus, the preparation of corpuscular-optical elements requires the reduction of nonlinearities to a reasonable level. They are caused, on the one hand, by effective field boundaries which are neither plane nor plane-parallel and, on the other hand, by faults in the transverse field distribution. Other causes of aberrations are the longitudinal components of end fields and the geometrical aperture defects which lead to the aberrations known from light optics also without the longitudinal components' being taken into account. In the application of numerous corpuscular-optical elements for the design of linear or circular accelerators, special importance is attached to the elimination of undesired nonlinear effects in order to obtain good beam quality and low activation of experimental facilities. (auth)

17660 SIMULTANEOUS ACCELERATION OF TWO BEAMS IN A LINEAR ACCELERATOR. Westcott, C. H. (Chalk River Nuclear Labs., Ont.). Acta Phys. Pol.; A38: 515-20(Nov 1970).

The Canadian Project for an Intense Neutron Generator required for maximum utility two separate beams of 1 GeV protons from a single linac, with currents roughly in the ratio 100:1. The system was continuous (i.e., unpulsed, although of course the beam had a radio frequency time-variation) and it was desired that both beams be similarly continuous. A simple method of achieving this is described. (auth)

17661 VARIATION IN THE POSITION OF THE CENTRAL AXIS MAXIMUM BUILDUP POINT WITH FIELD SIZE FOR HIGH-ENERGY PHOTON BEAMS. Almond, P.; Van Roosenbeeke, E.; Brown, R.; Milcramp, J.; Williams, C. B. (M. D. Anderson Hospital, Houston, Tex.). Brit. J. Radiol.; 43: 911(Dec 1970).

During preliminary tests of a 25 MeV linear accelerator for therapeutic use, it was found that the position of the central axis maximum build-up varied with field size, but was independent of a flattening filter. The machine was capable of producing photon fields greater than 35 × 35 cm at 1 m. All fields measured were of square cross section. (UK)

17662 TECHNIQUE FOR THE COMPUTATION OF CHARGED-PARTICLE TRAJECTORIES IN RADIO-FREQUENCY QUADRUPOLE DEVICES. Chisholm, T.; Stark, A. M. (Mullard Research Labs., Redhill, Eng.). J. Phys., D (London); 3: 1717-26(Nov 1970).

A method of computing the trajectories of charged particles which would occur in a real quadrupole device is presented. A successive, over-relaxation procedure is used first to solve the Laplace equation for the specified electrode system. Subsequently a simple Runge–Kutta integration is used to compute the trajectory. A number of results are presented showing that the conditions necessary for stable trajectories in the particular system studied are more restrictive than those predicted by the hyperbolic solution. (auth) (UK)

17663 COCKCROFT–WALTON ELECTRON ACCELERATOR FOR RADIATION CENTER OF OSAKA PREFECTURE. Yoshida, Toshio (Radiation Center of Osaka Prefecture, Sakai, Japan); Kitagawa, Michiharu; Miyashita, Kyoichi; Nagai, Akio; Ueda, Kazuhiro. Mitsubishi Denki Giho; 44: 1215-19(Sep 1970). (In Japanese).

A Cockcroft–Walton electron accelerator has been built and delivered to the Radiation Center of Osaka Prefecture. This is a totally enclosed electron beam irradiation device rated at 600 keV, 3 mA, and very small in size because of the use of SF_6 gas as insulation. In its construction, a high voltage generator producing 600 kV and the electron beam irradiator are arranged separately, but connected with extra high voltage cables. In addition to these features, it has an electron gun which is very easy to change. Performance of the accelerator is described. (auth) (Japan)

17664 A YIELD ESTIMATION FOR NEGATIVE HEAVY IONS, EMITTED FROM METAL TARGETS BY HEAVY PARTICLE BOMBARDMENT IN THE MeV-REGION. Mokler, P. H. (Kernforschungsanlage, Juelich, Ger.). Nucl. Instrum. Methods; 91: 267-8 (1971).

The yield of negative ions emitted from targets of Cu, Ag, and Au is estimated by extrapolating measured values for the case where the primary heavy ions have an energy of some MeV. This case is of special interest in a suggested device, which consists of two tandem Van de Graaff accelerators with opposite polarity of the high voltages. In this device the emitting target is placed at the terminal of the first accelerator, and the source of the bombarding ions is at ground potential. The estimate shows that under certain conditions currents of relatively large intensities and high energies can be achieved. (auth)

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PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 15918, 17253, 17254, 17262, 17301, 17607, 17621, 17629, 18185, 18186, 18231, and 18232.

17665 (GA–9364) COHERENT SCATTERING LAW FOR POLYCRYSTALLINE BERYLLIUM. Borgonovi, G. M. (Gulf General Atomic, Inc., San Diego, Calif.). 16 May 1969. Contract AT(04-3)-167. 44p. Dep. NTIS.

A new calculation of the coherent one-phonon scattering law for beryllium is presented in which the dependence on the mesh is limited. The coherent scattering law for a single crystal is derived and extended to the polycrystalline case. The scattering law is compared with previous derivations and with experimental results. (J.W.R.)

17666 EVIDENCE FOR QUARTET STRUCTURE IN MEDIUM AND HEAVY NUCLEI. Danos, M.; Gillet, V. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett.; 34B: 24-6(18 Jan 1971).

The second differences of the nuclear masses keeping T constant are discussed for even-even nuclei throughout the mass table. They are shown to be consistent with the quartet picture of weakly interacting tight two-proton two-neutron structures. (auth)

17667 EXPERIMENTAL INVESTIGATION OF 1/v-ABSORBERS IN A 1/E-NEUTRON FLUX. Bensch, F. (Oesterreichische Hochschule, Vienna). Atomkernenergie; 15: 273-4 (1970). (In German).

Disc-shaped 1/v absorbers have been irradiated at a beam hole as well as in an appropriate area 35 cm above the core of the TRIGA Mark II reactor. A 1/E spectrum of the slowed-down neutrons is given in the irradiation positions. The measured absorption rates correspond sufficiently well with values to be expected from theoretical considerations. (auth)

17668 ONE-SPEED NEUTRON TRANSPORT WITH ANISOTROPIC SCATTERING BY THE TRANSFER MATRIX METHOD. Caroll, Gerhard Albert. New York; New York Univ. (1969). 284p. University Microfilms Order No. 70-19,279.

Thesis.

The transfer-matrix method is applied to the solution of several one-speed neutron-transport problems in slab geometry. The specific problems considered are the problem of reflection and transmission by a slab, the Milne problem, and the critical problem with symmetric reflectors. The solutions are written in terms of integral operators which are derived explicitly as functions of the slab cross sections and thickness. The scattering cross section is expressed as a series of Legendre polynomials of arbitrary order. Treatment of nonabsorbing and multiplying media is given in detail. Numerical solutions for the three problems are obtained by expanding the angular distribution in a series of double Legendre polynomials. A procedure is presented which yields accurate values of the scattered distribution when neutrons are monodirectionally incident on a slab. Among the problems considered which lack a precise treatment in the literature is the criticality problem for slabs with symmetric finite reflectors. The calculational advantages of the transfer-matrix method are demonstrated, and explicit comparisons of computing times with invariant imbedding and doubling techniques are given. (Diss. Abstr. Int., B)

17669 GENERALIZATION OF THE NODAL APPROXIMATIONS TO THE LINEAR BOLTZMANN EQUATION APPLIED TO PROBLEMS IN NEUTRON TRANSPORT THEORY. Stenstrom, Dennis Gabriel. Seattle; Univ. of Washington (1970). 188p. University Microfilms Order No. 70-19,660.

Thesis.

A generalized nodal approximation to the one-dimensional neutron transport equation is developed; and the procedure for its extension to energy-dependent multidimensional problems, outlined. The most attractive feature of the method is the possibility of reducing the number of angular nodes while still retaining the same accuracy. The advantages of the approximation are demonstrated in some homogeneous and inhomogeneous source problems. Numerical evaluation is performed on model problems in monoenergetic neutron transport in plane geometry. These problems include the determination of the Milne asymptotic decay constant, the critical problem, and the isotropic slab albedo problem. In the latter two problems, the emphasis is on the calculation of the angular flux rather than integrated quantities since this is where conventional methods usually fail. These problems have demonstrated that the number of angular nodes required for a given accuracy can be reduced by a factor of two to four by using reasonable trial solutions, and that normally improved results will be obtained whenever trial solutions are used which are a better approximation to the trial solution than is an isotropic distribution. The procedure for extending the generalized nodal approximation to more realistic problems, such as those involving energy dependence and multidimensional geometries, is outlined and discussed since it is for these problems that the method will be particularly advantageous and useful. (TSS) (Diss. Abstr. Int., B)

17670 SOLUTION TO THE BOLTZMANN EQUATION FOR MONOENERGETIC NEUTRONS IN A SLAB. Boffi, Vinicio C.; Molinari, Vincenzo G. (CNEN, Bologna). Meccanica; 5: 177-86(Sep 1970).

A physical solution to the linear integro–differential Boltzmann equation, which governs the stationary distribution of the flux of monoenergetic neutrons in the interior and at the boundary of an infinite slab of finite thickness, is presented. Results for both the angular and the total fluxes are obtained by properly accounting for the boundary conditions of the problem and by a Fourier transform of the original Boltzmann equation. An integral linear Fredholm equation for the Fourier transform of the total flux is thus derived. The solution of such an equation is given two different representations according to the two decompositions devised for the given Fredholm kernel. The solution obtained in each case is finally inverted termwise to yield the sought total flux in the original space. The result for the angular flux follows, then, directly from the result for the total flux. (auth)

17671 HYBRID COMPUTER METHOD FOR TWO-DIMENSIONAL CALCULATIONS INVOLVING THE LAPLACIAN OPERATOR. Jaworski, Richard Lee. Ames, Iowa; Iowa State Univ. (1969). 69p. University Microfilms Order No. 70-7708.

Thesis.

Hybrid computer solutions of partial differential equations involving space and time variables are often made by representing a single spatial variable with the continuous independent variable of the analog computer and the time variable as discrete time increments. This is known as the continuous space, discrete time method. Because the analog computer has only one continuous independent variable, this method has been limited to the continuous description of a single spatial variable and modal approximations of all remaining spatial variables. In this study, spatial variables are related through a parametric variable. A differential equation whose solution is a function of the original spatial variables is formulated in terms of one parametric variable which can be represented by the one continuous variable available on a hybrid computer. As an illustration of this related independent variables approach, the coordinates of a polar coordinate system are represented by the spiral of Archimedes, $r = k\theta$. The Laplacian operator in r and θ is integrated over a differential area defined by the spiral, and partial derivatives with respect to r and θ are approximated by differences between values of the dependent variable at adjacent spiral revolutions. r and θ are then expressed in terms of the parametric variable S, $r = K_1S$, and $\theta = k_2S$ so the Laplacian operator is reduced from two spatial variables to one parametric variable. This method was applied to the two dimensional diffusion equation describing the neutron flux in an infinite cylindrical reactor. Critical enrichment calculations performed using a digital computer code demonstrated the validity of the related independent variables technique and that the method was applicable to reactor configurations which did not have a flux gradient at the center of the reactor. When compared with a standard two dimensional method, a 250% savings in execution time was noted. (Diss. Abstr. Int., B)

17672 ON A TIME-DEPENDENT INTEGRO–DIFFERENTIAL EQUATION IN RADIATIVE TRANSFER AND NEUTRON TRANSPORT THEORY. Thomassen, Richard Raymond. Pullman, Wash.; Washington State Univ. (1970). 52p. University Microfilms Order No. 70-25,005.

Thesis.

A time-dependent integro-differential equation of radiative transfer (neutron transport) is solved for a semi-infinite isotropic scattering medium in which an initial radiation intensity is specified. The time-dependent integro-differential equation is solved using Laplace transform methods and the Wick-Chandrasekhar approximation technique. The problem is considered with the semi-infinite scattering medium bounded by a vacuum or by an overlying atmosphere where there is only absorption and scattering of radiation. (Diss. Abstr. Int., B)

17673 DISTRIBUTION OF THERMAL NEUTRONS IN A CYLINDRICAL CELL. Laletin, N. I. At. Energ. (USSR); 28: 242-3(Mar 1970). (In Russian).

In a multi-zone cylindrical cell there are constant sources of thermal neutrons in each zone. It is assumed that the thermal neutron flux is described by a single-velocity transfer equation with isotropic neutron scattering and the neutron interaction being characterized by the total interaction cross section and by the absorption cross section. An expression is given for the neutron distribution in each cell zone. Values are calculated for neutron fluxes at the zone boundaries. The error is less than 0.2 to 0.3% for a two-zone cell. The two-zone approximation in most cases represents a suitable compromise between accuracy of the calculation and extensiveness of the required calculations. (TTT).

17674 MODAL APPROXIMATIONS IN TIME-DEPENDENT REACTOR AND NEUTRON KINETICS CALCULATIONS. McConnell, Benjamin Wade. Blacksburg, Va.; Virginia Polytechnic Inst. (1970). 77p. University Microfilms Order No. 70-24,220.

Thesis.

The solution of the space, time, and energy-dependent diffusion approximation of the transport equation by the method of modal expansions is considered. The basic concept of the modal expansion method, as devised by Stacey, involves replacing the "exact" equation under consideration by a more mathematically tractable set of approximate equations with a reduced number of independent variables. To illustrate the procedures involved, the numerical solutions of the pulsed neutron thermalization problem in both a bare and a reflected non-multiplying slab and the neutron kinetics problem for a fast dilute assembly are considered. In each of these examples, the time-dependent calculation requires the solution of a non-symmetric matrix eigenvalue problem which is solved by utilizing the QR algorithm. In addition, some methods used in the selection of the expansion modes and related weighting operators are briefly considered. (Diss. Abstr. Int., B)

17675 POLARIZED NEUTRON PASSAGE THROUGH FERROMAGNETIC FILMS. Drabkin, G. M.; Trunov, V. A.; Dmitriev, R. P. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz.; 40: 1317-19(Jun 1970). (In Russian).

Experimental studies were made of the method for producing a spatial periodic magnetic field for resonance inversion of polarized neutron beams by means of ferromagnetic films. It is shown that the film filter is highly efficient and it can be well controlled by resonator temperatures. Thus, experiments confirmed that ferromagnetic films may be used as effective filters during analysis of polarized neutron velocities. (R.V.J.)

17676 TEMPERATURE DEPENDENT THERMAL-NEUTRON DIFFUSION COEFFICIENTS IN H_2O AND D_2O. Pappano, Alfred William. Morgantown, W. Va.; West Virginia Univ. (1969). 76p. University Microfilms Order No. 70-15,260.

Thesis.

Utilizing the Brown and St. John cross-section model for neutron elastic scattering with the assumptions of isotropic scattering in the center-of-mass system and an isotropic Maxwellian velocity distribution of moderator nuclei, calculations are presented for the first-order spherical-harmonic expansion coefficient of the total scattering probability which is valid for any general moderator mass (M). This is accomplished initially by an independent derivation and verification of Smelov's $\sigma_{s1}(E - E')$, which is subsequently integrated over all final energies to obtain a unique analytic expression for $\sigma_{s1}(E)$. Application of this function is shown in the formulation of an energy-dependent diffusion coefficient whose flux-weighted value is then numerically integrated over thermal energies to obtain average thermal-neutron diffusion coefficients at various temperatures. For D_2O this approach has led to values of $\bar{D}$ that are within experimental error at most temperatures while for H_2O these predictions were inconsistent due to the inability of this model to describe adequately the total scattering cross section of hydrogen in H_2O. (Diss. Abstr. Int., B)

17677 ORIENTED GRAPHITE AS A NEUTRON MONOCHROMATOR. Riste, T. (Institutt for Atomenergi, Kjeller, Norway). pp 91-104 of Instrumentation for Neutron Inelastic Scattering Research. Vienna; International Atomic Energy Agency (1970).

From Meeting on Instrumentation for Neutron Inelastic Scattering Research, Vienna, Austria. See STI/PUB-275; CONF-691220.

A number of samples of oriented graphite of various thicknesses and of mosaic widths in the range 0.8 to 3.0° have been investigated for reflectivity of thermal neutrons. The observed values agree rather well with those calculated on the assumption of ideally imperfect samples. The peak reflectivity and the integrated reflectivity were found to be superior to other monochromators tested by a factor of about 2 to 10. For 4-Å neutrons peak reflectivities above 0.9 can easily be attained. An important feature is the absence of double Bragg scattering in graphite, leading to a considerable reduction of the intensity of extraneous neutrons in the primary beam. This was demonstrated by comparing the neutron spectra reflected from graphite and zinc monochromators. The merit of graphite monochromators in different set-ups for inelastic scattering experiments is discussed. (auth)

17678 REFLECTIVITY OF NEUTRONS BY DISTORTED COPPER CRYSTALS. Dymond, R. R.; Brockhouse, B. N. (McMaster Univ., Hamilton, Ont.). pp 105-15 of Instrumentation for Neutron Inelastic Scattering Research. Vienna; International Atomic Energy Agency (1970).

From Meeting on Instrumentation for Neutron Inelastic Scattering Research, Vienna, Austria. See STI/PUB-275; CONF-691220.

The absolute reflectivities of the (200) planes of two mechanically distorted copper crystal slabs have been measured in reflection and transmission over a wavelength range from 0.8 to 2.0 Å. The crystals, which had rocking curves with FWHM of about 30 minutes of arc, had integrated reflectivities ranging from about 6 minutes to 17 minutes, and peak reflectivities ranging from 20 to 55% for the different wavelengths. In view of the high angles of take-off (small d-spacing, 1.8 Å) these results compare favorably with those for any known type of neutron monochromator. The results are compared with calculations based on Bacon and Lowde's model of an infinite mosaic slab, using effective linear absorption coefficients to account for the effect of simultaneous reflections. (auth)

17679 TIME-DEPENDENT THERMALIZATION OF NEUTRONS IN AN EINSTEIN SOLID WITH APPLICATION TO ZIRCONIUM HYDRIDE. von Blatz, Ralph (Univ., Karlsruhe, Ger.). Atomkernenergie; 16: 201-5(1970). (In German).

The Einstein model of a solid is investigated in terms of its neutron thermalization properties. It is shown that the energy mode concept is valid although there is no corresponding discrete time eigenvalue. Thermalization in zirconium hydride may be explained by the Einstein model for times $\tau < 30\ \mu s$, whereas for longer times the influence of the Debye part of the lattice vibrations dominates. This effect is discussed with the aid of the Heavy Crystal- and the Heavy Gas model. (auth)

17680 PROTON DYNAMICS IN ICE STUDIED BY INELASTIC SCATTERING OF SLOW NEUTRONS. Burgman, J. O. (Royal Inst. of Tech., Stockholm). Atompraxis; 16: 324-8(Sep-Oct 1970).

The lattice dynamics of ice between 143°K and the melting point was studied by inelastic scattering of cold neutrons. It was shown that the sharp peaks in the ice spectrum close to the melting point are preserved even at low temperatures. In this neutron-scattering experiment, however, only energy-gain processes are studied, and for such processes the temperature dependence of the Boltzmann factor causes the intensities of the peaks to decrease with decreasing temperature. A comparison with infrared and Raman spectroscopy was carried out in the low-frequency region, and satisfactory agreement was shown to exist between observed peaks in the neutron-scattering spectra and intermolecular bands observed in infrared and Raman spectral investigations concerning the structure of water and ice. (auth)

17681 ROTATIONAL MOLECULAR MOTION AND THE TRANSIENT NATURE OF LIQUIDS AS SEEN BY SLOW-NEUTRON SCATTERING. Larsson, K. E. (Royal Inst. of Tech., Stockholm). Phys. Rev., A; 3: 1006-22(1 Mar 1971).

The analysis of neutron spectra scattered from molecular solids and liquids presents a formidable problem which so far has been only slightly touched upon. For a period of ten years, the translational motions of atoms in monatomic liquids have been investigated by neutron spectroscopists; their theoretical interpretation has reached a certain degree of refinement. An understanding of the effects of rotational motions on the neutron spectra scattered from molecular liquids, however, has not been developed to the same degree. The aim of the present work is to use some simple but reasonable model for the translational motions and to investigate in more detail the effect of the various possible rotational motions on the observed neutron spectrum. The general principle used is that translational and rotational motions are statistically uncorrelated. Thus, when the molecule as a whole vibrates and diffuses, it is assumed that it can also perform librations, free rotations, or rotation diffusion. Phonon expansions are done for the molecular vibrations and librations. Sears' basic theory is used to describe the free rotations and rotational diffusion. A cross section is obtained which contains all the basic components in the scattered-neutron spectrum. A discussion of "good"- and "bad"-resolution measurements is carried through. The value of older neutron-linewidth determi-

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nations is discussed. It is concluded that the resolution width ought to be ≤0.1 × (the width of the rotational spectrum) if finer details of the rotational motion should be observed as resolved structure. With the aid of good-resolution data it is shown that the nature of the rotational motion changes drastically over the liquid range, from librations to almost free rotations. Comparison is made to changes of rotational motion of ions in the phase transition from the ferro- to the para-electric phase in the solid state. It is shown that from such observations of molecular motion the liquid appears as a phase transition or as a transient phenomenon. (auth)

17682 APPLICATION OF INTERFERENCE LAYERS TO THE OPTICS OF X RAYS AND NEUTRONS. Croce, P.; Pardo, B. (Paris Univ., Orsay, France). Nouv. Rev. Opt. Appl.; 1: 229-32(Jul-Aug 1970). (In French).

The propagation of x rays and neutrons in a multiple-layer system is studied for the case of negligible Laue diffraction. The x rays and neutrons, which are at grazing incidence, behave as ultraviolet radiation at normal incidence, the surface irregularities are of the same order of magnitude, and the layers have a thickness of several hundred angstroms. An experimental study was then made of the reflection of x rays by a triple interference layer. (France)

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Refer also to abstracts 17426, 17506, 17545, 17714, 17798, 17959, 17968, 17971, 18019, and 18022.

17683 (AD-711285) NUMERICAL INVESTIGATION OF THE DEUTERON GROUND STATE. Cahill, Philip T. (United States Naval Academy, Annapolis, Md.). 15 May 1970. 73p. (USNA-TSPR-6). NTIS.

Schrodinger's equation is used to compute the energy depth and range parameters used in various forms for the potential experienced by the two nucleons of the deuteron in its ground state. Analytic expressions for the wave function, effective range, scattering length, and root-mean-square radius for that system under the influence of a spherical square well are determined. For the more complex cases of potentials with exponential forms in them (excluding the cut-off exponential), analytic solutions are not so readily attainable; accordingly, a numerical scheme involving the Numerov iteration technique, a Runge–Kutta method particularly useful for second-order differential equations lacking first order terms and suggested by Raynal, was set up and programmed for use on the COMNET computer system using BASIC as the primary language. Parameters for various potentials were calculated and, as a result a new picture of the nucleus developed. While a complete search scheme for these parameters could not be formed, three programs were written which can, with a minimum of assistance from the programmer, determine the parameters for potential forms involving four arbitrary constants. Among the criteria they use are the values of the binding energy, scattering length, effective range, and root-mean-square radius. (auth) (USGRDR)

17684 (KFK-1055) INVESTIGATION OF T = 0 EXCITED STATES OF ^{4}He USING THREE-PARTICLE REACTIONS. Haase, E. L.; Hagelberg, R.; Wang, W. N.; Lin, E. K.; Saylor, D. P.; Fawzi, M. A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Aug 1970. 31p. (CONF-700417-2). Dep. NTIS (U. S. Sales Only).

From Joint Meeting of the German and Dutch Physical Societies, Eindhoven, Netherlands.

Using 52 MeV deuterons and 104 MeV α-particles coincidence measurements in three entrance channels were carried out for the following reactions: ^{4}He(d,d′t)^{1}H, ^{4}He(α,α′t)^{1}H, ^{6}Li(d,α′t)^{1}H, ^{4}He(α,α′^{3}He)n, ^{6}Li(d,α′^{3}He)n, ^{4}He(d,d′d)D, ^{4}He(α,α′d)D, and ^{6}Li(d,α′d)D. In measuring the correlations, the detector of the inelastic particle was kept at a fixed position and the second detector scanned over a range of coplanar angles favoring ^{4}He final state interactions. The data can be fitted consistently with six T = 0 excited states of ^{4}He, at 20.2 MeV, 21.1 MeV, 21.9 MeV, 25.5 MeV, 28.5 MeV and 31.8 MeV with widths (Γ) of 0.2 MeV, 0.8 MeV, 1.8 MeV, 2.9 MeV, 5.3 MeV and 5.6 MeV respectively. The validity of the sequential reaction mechanism is examined. The internal consistency of the level parameters for the three entrance and three decay channels as well as the symmetry of the extracted angular correlations about 0 and 90° in the recoil system (center of mass) agree very well with the model of sequential decay. The angular correlations agree well with the predictions of a simple theory using the impulse approximation. (auth)

17685 (KFK-1204) INVESTIGATION OF THE ELASTIC SCATTERING OF 104-MeV α PARTICLES IN ^{3}He. Fetscher, W.; Sattler, K.; Schmeing, N. C.; Seibt, E.; Weddigen, Ch. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jul 1970. 18p. (In German). Dep. NTIS (U. S. Sales Only).

The differential cross section for the elastic scattering of 104 MeV-α-particles on ^{3}He was measured and a double scattering experiment was prepared to determine the spin-orbit term of the optical potential. The differential scattering cross section shows a wide absorption minimum at θ_{CM} = 100°. The decline at forward angles can be explained qualitatively by an optical potential. The backwards peaking presumably results from neutron exchange. A partial wave analysis according to the "Strong-Absorption-Model" gives about 50% absorption for $l \leq 4$ and purely elastic scattering for $l \geq 6$. The experimental setup for making polarization measurements was tested by double scattering of α-particles on ^{4}He. (auth)

17686 (LA-4538) POLARIZATION OF ELASTICALLY SCATTERED TRITONS AND ^{3}He. Armstrong, D. D.; Keaton, P. W. Jr. (Los Alamos Scientific Lab., N. Mex.). Oct 1970. Contract W-7405-eng-36. 9p. Dep. NTIS.

The measurement of the polarization of tritons elastically scattered from ^{4}He has established this reaction as a good polarizer (or analyzer) for tritons. The polarization measurements were recently extended over a sufficient angular and energy range to allow a phase-shift analysis that more accurately describes both the cross-section and polarization data. Based on the assumption that the optical model potential for a triton is just the sum of the optical model potentials of its constituent nucleons suitably averaged over their internal motion in the triton, the polarization of tritons elastically scattered from nuclei is expected to be small. Measurements (at angles ~60°) give small polarizations for tritons elastically scattered from nickel and ^{54}Fe. (auth)

17687 (N-70-36659) INTERACTION OF INTERMEDIATE-ENERGY PROTONS WITH LIGHT NUCLEI. Roberts, W. K.; Vincent, J. S.; Boschitz, E. T.; Gutow, K.; Blecher, M.; (and others) (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug 1970. 57p. (NASA-TN-D-5961; E-5430). NTIS.

The elastic and quasi-elastic scattering of 600-MeV protons from light nuclei was studied. Differential cross sections were obtained for the scattering of protons from hydrogen, deuterium, helium-3, and helium-4. Polarization was measured for deuterium and ^{4}He nuclei. The p/p cross section data are in excellent agreement with the predictions for the Livermore phase shifts. Small-angle p/D, p/^{3}He, and p/^{4}He elastic scattering data are compared with calculations based on the multiple scattering theories of Watson and of Glauber. Large-angle p/D data are compared with the predictions of a model recently proposed by Kerman and Kisslinger. Quasi-free p/D scattering differential cross sections at 12° in the laboratory were measured for nine nuclei between atomic numbers A = 3 and A = 208 and follow very closely a cubic root of A dependence. (auth) (STAR)

17688 CROSS-SECTION MEASUREMENTS FOR THE REACTION ^{10}B(p,^{3}He)^{8}Be. Squier, G. T. A. (Queen's Univ., Belfast); Johnston, A. R.; Spiers, E. W.; Harbison, S. A.; Stewart, N. M. Nucl. Phys.; A160: 602-8(1971).

Cross sections were measured for the transitions to the ground state and first excited state of ^{8}Be and to the two 2^+ levels at 16.63 MeV and 16.93 MeV excitation in the reaction ^{10}B(p,^{3}He) at E_p = 49.5 MeV. The angular distributions of the cross section were compared with DWBA predictions. (auth)

17689 THREE-NUCLEON CALCULATIONS WITH REALISTIC FORCES. Malfliet, R. A. (Univ. of Utrecht); Tjon, J. A. Ann. Phys. (N. Y.); 61: 425-50(Dec 1970).

Within the framework of the Faddeev equations the triton binding energy, doublet scattering length, Coulomb energy, and S′- and D-state probabilities are determined. The two-particle interactions used are of the local Yukawa type and also include tensor forces. The sensitivity of the three-particle observables for variations of the two-body data is studied. Although no agreement with experiment is obtained, the results clearly favor the Van Oers–Seagrave value for the doublet scattering length. Finally, calculations are also performed using the local nucleon–nucleon potentials proposed by Reid; the results obtained for this set of potentials are $E_T = -6.5$ MeV and $a_t = 2.4$ F. (auth)

17690 NEUTRON-NEUTRON EFFECTIVE RANGE PARAMETERS FROM THE ^{3}H(^{2}H,^{3}He)2n AND ^{3}He(^{2}H,^{3}H)2p REACTIONS. Larson, H. T.; Bacher, A. D.; Nagatani, K.; Tombrello, T. A. (California Inst. of Tech., Pasadena). Nucl. Phys.; A149: 161-96(1970).

The energy spectra of ^{3}H and ^{3}He nuclei from the ^{3}He(^{2}H, ^{3}H)2p, ^{3}H(^{2}H, ^{3}He)2n, ^{3}He(^{2}H, ^{3}He)pn, and ^{3}H(^{2}H, ^{3}H)pn reactions were measured between 6 and 20° at a bombarding energy of 11 MeV. An upper limit of 5 μb/sr was determined for the cross section for producing a bound di-neutron at 6 and 7.5°. The ^{3}H(^{2}H, ^{3}He)2n and ^{3}He(^{2}H, ^{3}H)2p data together with previous measurements at higher energies were used to investigate the reliability of information obtained about the two-nucleon system from such three-body final state reactions. As an aid to these investigations, Born approximation calculations were made employing realistic nucleon–nucleon potentials and an antisymmetrized final state wave function for the five-particle system. These calculations reproduce many of the features observed in the experimental data and indicate that the role of complex exchange processes cannot be ignored. The results show that previous attempts to obtain information on the neutron–neutron effective range parameters from the ^{3}H(^{2}H, ^{3}He)2n reaction may have seriously overestimated the accuracy that could be obtained. (auth)

17691 PROTON–PROTON FINAL-STATE INTERACTION IN THE ^{2}H(p,pn)p REACTION. Ivanovich, M.; von Witsch, W.; Hungerford III, E. V.; Phillips, G. C. (Rice Univ., Houston, Tex.). Nucl. Phys.; A156: 616-28(1970).

The ^{2}H(p, pn) reaction was studied under conditions suitable for the observation of the proton–proton final-state interaction at relative energies in the p–p system between 0.0 and 2.5 MeV. A kinematically complete experiment was performed, detecting protons and neutrons in coincidence, for bombarding energies between 8 and 13 MeV. Models based on the Watson-Migdal theory were used to fit the experimental spectra and the possibility of extracting two-nucleon scattering parameters was investigated. A value of 7.7 ± 0.6 fm for the proton–proton scattering length was obtained. (auth)

17692 VECTOR POLARIZATION MEASUREMENTS AND PHASE-SHIFT ANALYSIS FOR d-α SCATTERING BETWEEN 3 AND 11 MeV. Keller, L. G.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Phys.; A156: 465-76(1970).

Vector-polarized deuterons from a tandem accelerator were used to measure the vector analysing power in d-α elastic scattering at deuteron energies from 3 to 11 MeV in steps of 1 MeV, for c.m. angles between 21 and 152°. A phase-shift analysis was carried out of the differential cross section and of tensor and vector polarization data. It was found that f-waves must be included above 8 MeV. The analysis confirms the presence of the two known d-wave resonances. The p-wave phase shifts were found to be small. An alternate solution with large p-wave phase shifts was found at 8 MeV. (auth)

17693 NEUTRON–NEUTRON SCATTERING PARAMETERS FROM ^{3}He(d,t)2p AND ^{3}H(d,^{3}He)2n REACTIONS. Larson, Harold Theodore. Pasadena, Calif.; California Inst. of Tech. (1970). 216p. University Microfilms Order No. 70-24,303.

Thesis.

The energy spectra of tritons and helium-3 nuclei from the reactions ^{3}He(d,t)2p, ^{3}H(d,^{3}He)2n, ^{3}He(d,^{3}He)pn, and ^{3}H(d,t)pn were measured between 6° and 20° at a bombarding energy of 10.9 MeV. An upper limit of 5 μb/sr. was obtained for producing a bound di-neutron at 6° and 7.5°. The ^{3}He(d,t)2p and ^{3}H(d,^{3}He)2n data, together with previous measurements at higher energies, have been used to investigate whether one can unambiguously extract information on the two-nucleon system from these three-body final-state reactions. As an aid to these theoretical investigations, Born approximation calculations were made employing realistic nucleon–nucleon potentials and an antisymmetrized final state wave function for the five-particle system. These calculations reproduce many of the features observed in the experimental data and indicate that the role of exchange processes cannot be ignored. The results show that previous attempts to obtain information on the neutron–neutron scattering length from the ^{3}H(d,^{3}He)2n reaction may have seriously overestimated the precision that could be attained. (Diss. Abstr. Int., B)

17694 PRECISE MEASUREMENT OF NEUTRON–PROTON TOTAL CROSS SECTION FROM 25 TO 60 MeV. Brady, F. P.; Knox, W. J.; Jungerman, J. A.; McGie, M. R.; Walraven, R. L. (Univ. of California, Davis). Contract AT(11-1)-GEN 10. Phys. Rev. Lett.; 25: 1628-31(7 Dec 1970).

The neutron–proton total cross section was measured to better than 1% in the energy range 25 to 60 MeV. The results agree with data at lower energies but are several percent higher than both previous measurements and current phase-shift predictions in this energy range. (auth)

17695 THREE-BODY CALCULATIONS OF ELASTIC DEUTERON–^{4}He SCATTERING WITH FADDEEV EQUATIONS. Hofmann, H. M.; Fick, D. (Univ., Erlangen, Ger.). Z. Phys.; 240: 420-9 (1970).

The Faddeev equations are applied to the deuteron–^{4}He system. For the interactions between the particles square-well potentials are used. In order to solve the Faddeev equations, the t-matrix is approximated by one separable term. The phase shifts of the elastic deuteron–^{4}He scattering are calculated. It is shown that the separable approximation with only one term is insufficient for such calculations. (auth)

17696 TWO-NUCLEON FINAL STATE INTERACTIONS AND THE ^{4}He(p,t)2p, ^{4}He(p,^{3}He)pn, AND ^{4}He(p,d)^{3}He REACTIONS AT 156 MeV. Bernas, M.; Bachelier, D.; Lee, J. K.; (and others) (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A156: 289-304(1970).

The pp and pn final state interaction (FSI) spectra were measured in the ^{4}He(p,t)2p and ^{4}He(p,^{3}He)pn reactions at 156 MeV. The Watson-Migdal treatment and the known scattering length were used to analyze the spectrum shapes at different small angles: the agreement obtained was quite good; the Watson-Migdal assumptions are better satisfied for higher primary energies. Use of a modified Born approximation for the pp spectrum further improves the fit. When comparing the absolute magnitudes of the three reactions, it appears that the ^{4}He(p,^{3}He)pn spectra should include mainly the singlet contribution. The angular distribution of the reaction ^{4}He(p,d)^{3}He was measured from 3 to 177° (c.m.). No evidence was found for excited states of ^{3}He. (auth)

17697 NEUTRON–ALPHA SCATTERING. Omojola, D. A. F. (Univ. of Lagos, Nigeria). J. Phys., A (London); 3: 630-52 (Nov 1970).

The following topics are covered: (1) A new formulation of the elastic neutron–alpha (n–^{4}He) scattering using the most general form of the nuclear interaction which includes the central, non-central exchange–linear spin–orbit, tensor and quadratic spin–orbit forces is given. (2) The resonating group method of Wheeler is employed to construct the five-body wave functions and from the Schroedinger equation a set of simultaneous integro–differential equations is derived. (3) The Hamada and Johnston potentials used are expressed in Gaussian form permitting analytical integrations and leading to great economy of computing time. There are repulsive cores in all states. (4) An extension of n–^{4}He scattering formulation to include the D-state of the alpha wave function is discussed. (5) The resulting integro–differential equations are then solved by the method of finite differences. Programs for computing the direct and indirect (kernels) terms and for the solution of the equations written in Algol language were prepared for the University of London Atlas computer. The equations are then solved at different incident neutron energies. (auth) (UK)

17698 STUDY OF THE REACTION ^{4}He(e,e'd)^{2}H. Skopik, Dennis Michael. Washington, D. C.; American Univ. (1970). 87p. University Microfilms Order No. 70-22,778.

Thesis.

The differential cross section of ^{4}He(e,e'd)^{2}H was measured at six angles and over an energy interval of 35–50 MeV. Since the center of mass and charge coincide, the reaction is expected to be primarily E2. The measured angular distribution of the deuterons is consistent with $\sin^2\theta\cos^2\theta$. The measured cross section is a factor of 10 lower than the predictions of earlier theory. Calculations in a direct reaction model were performed in an attempt to fit the magnitude of the experimental cross section and its energy dependence. (Diss. Abstr. Int., B)

17699 STUDY OF THE ^{3}H(p,p)^{3}H, ^{3}He(p,p)^{3}He, AND ^{3}H(p,n)^{3}He REACTIONS AT E_p = 156 MeV. Narboni, Ph.; Langevin-Joliot, H.; Didelez, J. P.; (and others) (Univ. Paris, Orsay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.81-2(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Differential cross sections were measured, using tritium and ^{3}He gaseous targets at low temperature. The (p,p) reactions were studied from 16° to 178° (CM) and the (p,n) reactions from 109° to 178° (CM). For backward angles, the ^{3}H(p,n)^{3}He cross sections are about one fourth as large as for elastic scattering. Preliminary theoretical calculations do not explain this difference. (France)

17700 COHERENT SCATTERING OF PIONS AND PROTONS ON ^{4}He, ^{3}He, ^{3}H AT ABOUT 1 GeV. Fain, J.; Gardes, J.; Meritet, L.; Querrou, M.; Riss, D. (Univ., Clermont-Ferrand, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.104-5 (May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The differential cross section for coherent elastic scattering of 1.12 GeV pions on ^{4}He was measured. The recoil nucleus detec-

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tion method was used. Some preliminary results concerning the scattering of 600 MeV protons on ^{4}He are also given. (auth) (France)

17701 D(p,2p)n REACTION AT 156 MeV. Takeutchi, F.; Yuasa, T.; Kuroda, K.; Sakamoto, Y. (Univ. Paris, Orsay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.186-7 (May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Quasi-free p-p scattering was studied at 156 MeV. The kinematic conditions were completely determined by measuring the angles of emerging protons and the kinematic energy of one of them. The experimental differential cross sections were compared to calculations based on the impulse approximation (spectator model) and also including effects of multiple scattering and final-state interactions. (auth) (France)

17702 USE OF NON-LOCAL SEPARABLE POTENTIALS IN THE STUDY OF $\alpha-\alpha$ ELASTIC SCATTERING. Pigeon, J.; Barguil, J.; Fayard, C.; Lamot, G. H.; El Baz, E. (Univ., Lyon). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.194-5(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Non-local separable potentials were used for the $\alpha-\alpha$ elastic scattering study below 100 MeV. Different shapes were tried giving a good agreement with experimental data. (auth) (France)

17703 QUASI-FREE SCATTERING IN THE D(p,2p)n REACTION FROM 25 TO 40 MeV. Durand, J. L.; Arvieux, J.; Fiore, A.; Perrin, C. (Univ., Grenoble, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.196-7(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The D(p,2p)n differential cross section $d^3\sigma/d\Omega_1 d\Omega_2 dE_1$ was measured in absolute value at bombarding energies of 25, 30, 35, and 40 MeV for a set of angles where the spectra were dominated by the direct knock-out mechanism. At these energies experimental cross sections are smaller than the cross sections given by impulse approximation calculations. (auth) (France)

17704 STUDY OF THE ELASTIC SCATTERING ^{4}He(t,t)^{4}He. Wery, M.; Seltz, R.; Bing, O.; Bonneaud, G.; Kraus, L. (CNRS, Strasbourg). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.201-2(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Cross sections for the elastic scattering of t by ^{4}He were measured in the range $0.8 \leq E_t \leq 3.85$ MeV (lab. system). Excitation functions were measured at center of mass angles 49.50°, 61.92°, 69.24°, 93.71°, and 108.44°. Angular distributions were measured at E_t = 1.75, 2.15, and 3.80 MeV. The resonance of 4.65 MeV in ^{7}Li was observed. A data analysis in the framework of S-matrix theory confirms spin and parity assignments of $\frac{1}{2}^-$ for this resonance. (auth) (France)

17705 STUDY OF THE $P_{\frac{3}{2}}$ AND $P_{\frac{1}{2}}$ STATES OF ^{5}Li BY THE RESONANCE SCATTERING ^{4}He(p,p)^{4}He. Kraus, L.; Linck, I.; Wery, M. (CNRS, Strasbourg). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.203-4(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The scattering of protons in helium gas was measured in the energy range 0.5 to 2 MeV. An analysis of various cross-section data is presented for E_p = 0.5 to 18 MeV. (auth) (France)

17706 MECHANISM OF THE ^{3}He(d,p)^{4}He REACTION FROM 2 TO 27 MeV. Allab, M.; Beaumevieille, H. (Institut d'Etudes Nucleaires, Algiers). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.207-8(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The angular distributions of the ^{3}He(d,p)^{4}He reaction was analyzed at $2 < E_d \leq 27$ MeV using a formalism describing simultaneously direct and compound processes. The direct mechanism is described by D.W.B.A. approximation; the characteristics of ^{5}Li* excited states around $E_x \simeq 20$ MeV were examined. (auth) (France)

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Refer also to abstracts 16581, 17403, 17642, 17688, 17704, 17706, 17818, 17826, 17896, 17968, and 18019.

17707 (INP-721) ELASTIC SCATTERING OF HIGH ENERGY HADRONS FROM DEFORMED ^{12}C NUCLEUS. Lesniak, H.; Lesniak, L. (Institute of Nuclear Physics, Krakow (Poland)). 1970. 17p. Dep. NTIS (U. S. Sales Only).

Elastic scattering of high-energy protons from deformed ^{12}C nuclei is calculated using the multiple collision theory and deformed harmonic oscillator wave functions. Calculated differential cross sections are compared with the experimental data. Good agreement is found for the oblate deformation. (auth)

17708 (INR-1200) ^{9}Be/d,α_0/^{7}Li/g.s./ AND ^{9}Be/d, α_1/^{7}Li*/ 470 keV/ REACTIONS IN THE 0.9-2.2 MeV ENERGY RANGE. Saganek, A.; Sledzinska, I.; Turos, A.; Wilhelmi, Z.; Zwieglinski, B. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 29p. Dep. NTIS (U. S. Sales Only).

Angular distributions and total cross sections of ^{9}Be(d,α_0) ^{7}Li(g.s.) and ^{9}Be(d,α_1) ^{7}Li*(470 keV) reactions were measured over the angular range from 15 to 165° (LAB.) in 100-keV steps. Detailed description of the experimental technique is given. (auth)

17709 (JINR-P15-5519) PROBLEM OF THE NEAR-THRESHOLD ANOMALY IN INTERACTION OF PROTONS WITH ^{9}Be NUCLEI AT 2.06 MeV. Gopych, P. M.; Salatskii, V. I.; Sizov, I. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1971. 6p. (In Russian). Dep. NTIS (U. S. Sales Only).

The elastic scattering of protons on the ^{9}Be nuclei is measured for angles of 120° and 135° of lab. sys. in the energy range 1.97 to 2.18 MeV. No anomalies denoting the existence of narrow resonances in the range of the threshold (2.06 MeV) of the reaction ^{9}Be(p,n)^{9}B are observed. (auth)

17710 REACTIONS (p,t) AND (p,^{3}He) ON LIGHT NUCLEI. Olsen, David Kurt. Minneapolis; Univ. of Minnesota (1970). 139p. University Microfilms Order No. 70-20,222.

Thesis.

Differential cross sections are measured for (p,t) and (p,^{3}He) reactions at 39.8 MeV from ^{14}C, ^{17}O, ^{18}O, ^{20}Ne, and ^{22}Ne targets to selected states in the residual nuclei. The ^{14}C(p,t)^{12}C data and previous 1p shell (p,^{3}He) data are compared with DWBA calculations using intermediate-coupled, 1p shell wave functions. For several transitions within the 1p shell for which both L = 0 and L = 2 are allowed, the shapes of the angular distributions indicate that the L = 0 component is being predicted to be too large relative to the L = 2 component. Generally, the calculated integrated cross section ratios to the ground states are in reasonable agreement with experiment. The ^{22}Ne(p,t)^{20}Ne data to positive parity, K = 0 rotational bands is compared with DWBA calculations using pure Nilsson wave functions for these states, and there is marked disagreement between the calculated and experimental integrated cross section ratios. In addition, two cases are found in which the present theory is inadequate to predict the (p,t) to (p,^{3}He) cross section ratios to isobaric analog states when both T = 0 and T = 1 are allowed for the (p,^{3}He) reaction. Several instances are also observed in which the experimental transitions proceed in violation of the standard selection rules. (Diss. Abstr. Int., B)

17711 1^+ ISOSPIN DOUBLET IN ^{12}C. Reisman, Frederic David. College Park, Md.; Univ. of Maryland (1970). 67p. University Microfilms Order No. 70-23,312.

Thesis.

Isospin mixing between the 12.71-MeV ($J^\pi = 1^+$, T = 0) and 15.11-MeV ($J^\pi = 1^+$, T = 1) energy levels of ^{12}C was studied using the ^{13}C(^{3}He,α)^{12}C reaction using 2.5-MeV ^{3}He particles. The relative α-particle widths Γ_α/Γ were measured for both levels and used to determine the isospin mixing parameter for the two levels. In addition, the γ-ray branching ratios of the levels to the ground state and several excited states of ^{12}C were measured. The results were compared with theoretical calculations of M1 transition strengths. (Diss. Abstr. Int., B)

17712 STUDY OF ^{6}Li STATES FROM THE ^{7}Li(^{3}He,α)^{6}Li REACTION. Kane, Raymond Joseph. Washington, D. C.; Georgetown Univ. (1970). 154p. University Microfilms Order No. 70-21,273.

Thesis.

A study of the energy levels of ^{6}Li from the ^{7}Li(^{3}He,α)^{6}Li reaction is made. A coincidence timing technique is combined with one- and two-parameter analysis for the identification of the energy levels of the ^{6}Li nucleus excited in this reaction. Isospin is thought to be a good quantum number for light nuclei and energy levels of relatively low excitation energy. Isospin selection rules impose restrictions on the decay modes of levels for which isospin is a valid quantum number. The applicability of isospin selection rules to the ^{6}Li nucleus and the validity of present isospin assignments for ^{6}Li are studied by direct observation of ^{7}Li(^{3}He,α)^{6}Li decay products. (Diss. Abstr. Int., B)

17713 LEVELS AT 4,63 MeV AND 5,6 MeV IN ^{7}Li STUDIED IN (d,p) REACTIONS. Holtebekk, Trygve; Monsrud, Arne E. (Univ. of Oslo). Phys. Norv.; No. 3, 215-19(1969).

The ^{6}Li(d,p)^{7}Li reaction leading to the 4.63 MeV level and an assumed level near 5.5 MeV in ^{7}Li was studied with deuterons of 1.88 MeV energy. Values obtained for the excitation energy and the width of the 4.63 MeV level are in good agreement with previously accepted values. The distribution of protons between 0 and 90° is nearly isotropic. The differential cross section for the reaction was determined to be (0.6 ± 0.3) mb/sr. A proton peak corresponding to a level at (5.65 ± 0.02) MeV in ^{7}Li, due to the ^{6}Li(d,p)^{7}Li reaction is lacking. (auth) (Norway)

17714 POLARIZATION TRANSFER IN THE (p,n) REACTION ON LIGHT NUCLEI AND NUCLEON–NUCLEON PHASE SHIFTS AT 30 AND 50 MeV. Ramavataram, K.; Ho-Kim, Q. (Univ. Laval, Quebec). Nucl. Phys.; A156: 395-405(1970).

The polarization transfer coefficient α_1 for neutrons emitted in the forward direction in the charge exchange (p,n) reactions on ^{2}H, ^{6}Li, and ^{7}Li target nuclei for incident proton energies of 25 to 100 MeV was calculated in the impulse approximation. The energy-dependent and energy-independent nucleon-nucleon phase shifts of Arndt and McGregor and the Yale phase shifts were used. Experimental values of α_1 recently obtained at proton energies of 30 and 50 MeV are in disagreement with the results of the calculation based on Yale phase shifts, but show a preference for Arndt-McGregor phase shifts. (auth)

17715 A STUDY OF SOME (p,t) AND (p,^{3}He) REACTIONS INDUCED BY 49.5 MeV POLARIZED PROTONS. Nelson, J. M.; Chant, N. S.; Fisher, P. S. (Nuclear Physics Lab., Oxford). Nucl. Phys.; A156: 406-48(1970).

The polarization analyzing powers of the reactions ^{12}C(p,t)^{10}C, ^{16}O(p,t)^{14}O, ^{16}O(p,^{3}He)^{14}N, and ^{28}Si(p,t)^{26}Si were measured using a 49.5-MeV polarized proton beam. The differential cross sections were measured in companion experiments with an unpolarized beam. The predictions of a spin-dependent distorted wave Born approximation theory were compared with the data and satisfactory agreement was obtained only if finite-range corrections are included in the calculations. Optical-model potentials, which reproduce elastic scattering data, were used in all calculations. Despite moderate insensitivity of the predictions to the presence of spin-orbit forces, the strength of the tri-nucleon spin-orbit potential was deduced to be less than 5 MeV. Calculations in which different transferred angular momenta enter coherently were carried out and the effect of the interference term is shown to be small for the case considered. (auth)

17716 THE PHOTODISINTEGRATION OF ^{12}C LEADING TO EXCITED STATES OF ^{11}B AND ^{11}C. Medicus, H. A.; Bowey, E. M.; Gayther, D. B.; Patrick, B. H.; Winhold, E. J. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys.; A156: 257-75(1970).

Gamma spectra from the reactions ^{12}C(γ,nγ′) and ^{12}C(γ,pγ′) were measured at 112° using bremsstrahlung photons with end-point energies 24.5, 27, 33, and 42 MeV in order to study the transitions from the giant dipole resonance in ^{12}C to excited states in ^{11}B and ^{11}C. The γ rays were detected in a Ge(Li) detector. Using measured response functions of the detector to γ rays the fractions of decays of the excited ^{12}C nucleus that proceed through the various excited states of the residual nucleus were determined. The fractions of neutrons and protons emitted to the ground states of ^{11}C and ^{11}B were found by measuring the ^{11}C β^{+} activity, combining it with the known $(\gamma,n_0)/(\gamma,p_0)$ integrated cross-section ratio. Approximately 90% of the neutron and proton emission proceed through the ground states, with approximately 5% to each of the first excited states and the remainder shared among the higher levels of odd and even parity. The behavior of the cross sections for transitions to the excited states was deduced as a function of excitation energy, and it appeared that most of the cross sections are concentrated into regions only a few MeV wide. The results are interpreted in terms of current models of the giant resonance in ^{12}C and of the unified model for the states in ^{11}B and ^{11}C. It appeared that only a quite complex structure of the ^{12}C ground state can explain the excitation of these many states of negative and positive parity. Comparison of proton and neutron emitting reactions to analog states also permits some conclusions to be drawn about isospin impurities in the giant resonance. (auth)

17717 ION–ION POTENTIALS IN A TWO CENTER MODEL. Mosel, U. (Univ. of Tennessee, Knoxville, Oak Ridge National Lab., Tenn.); Thomas, T. D.; Riesenfeldt, P. Phys. Lett.; 33B: 565-7(21 Dec 1970).

The two center shell model was used to calculate ion–ion potentials for ^{12}C + ^{12}C, ^{16}O + ^{16}O, and ^{18}O + ^{18}O. Because of the ion shell structure the ^{16}O + ^{16}O potential is significantly shallow, in agreement with optical model potentials derived from scattering experiments. A mechanism is proposed to calculate the transition between adiabatic and nonadiabatic potentials as a function of the ion energies. (auth)

17718 CAN THE 7.65 MeV 0^{+} STATE IN ^{12}C BELONG TO A LINEAR CHAIN OF α-CLUSTERS? De Takacsy, N.; Das Gupta, S. (McGill Univ., Montreal). Phys. Lett.; 33B: 556-8 (21 Dec 1970).

The low-lying bands of ^{12}C are studied using an α-cluster model that allows for the mixing of intrinsic configurations of different shapes through an algebraic approximation to the required Hill-Wheeler integrals. The intrinsic state for the ground state band does not deviate much from an equilateral triangle of three α-clusters. However, the linear chain configuration of three α's is unstable against deviation from linearity and as a result, the second intrinsic state of positive parity is very far from a linear chain of three α's. (auth)

17719 n-p CORRELATIONS IN THE ^{12}C(d,pn)^{12}C REACTION: A SEARCH FOR PROXIMITY SCATTERING AND SINGLET DEUTERON CONTRIBUTIONS. Sandler, Julian. Houston Tex.; Rice Univ. (1970). 162p. University Microfilms Order No. 70-23,570.

Thesis.

The ^{12}C(d,pn)^{12}C reaction was studied in a kinematically complete experiment at geometries suitable for proximity scattering and singlet deuteron reaction mechanisms. The reaction is dominated by sequential decay via the 3.51--3.56 MeV doublet in ^{12}N. Evidence for singlet deuteron production at low bombarding energies is presented. Published reports of proximity scattering contributions to this reaction are not substantiated by this study. (Diss. Abstr. Int., B)

17720 THEORY OF α_0 ANGULAR DISTRIBUTIONS FROM THE REACTION ^{10}B(d,α) WITH THE POSSIBILITY OF A DYNAMICAL CLUSTER STRUCTURE OF ^{10}B. Nalda, J.; Barriuso, T.; Casanova, J. (Instituto de Estudios Nucleares, Valladolid, Spain). Nucl. Phys.; A149: 350-62(1970). (In French).

The angular dependence of the differential cross section is calculated by means of dispersion theory, with excitation energies from 2 to 14 MeV, for three non-relativistic Feynman diagrams. The contribution of these internal mechanisms is studied by the shift of singularities and a correspondence for each mechanism with a dynamical cluster structure of ^{10}B. Theoretical results interpret the experimental facts in the above interval of energies. (auth)

17721 ELECTRON SCATTERING FROM ^{13}C. Yang, C. S., Tomusiak, E. L.; Gupta, R. K.; Caplan, H. S. (Saskatchewan Accelerator Lab., Saskatoon). Nucl. Phys.; A162: 71-81(1971).

Cross sections for elastic and inelastic electron scattering from ^{13}C have been measured using both enriched solid and gas targets. Analysis of the elastic form factor supports an earlier result that the rms charge radius of ^{13}C is smaller than that of ^{12}C. Ten levels at excitation energies of 3.69, 7.55, 8.86, 9.50, 11.72, 11.97, 12.32, 13.76, 15.11 and 19.15 MeV were observed at momentum transfers ranging from 0.63 to 1.23 fm^{-1}. Calculations of the inelastic form factors using the wave functions of Boyarkina, Cohen and Kurath, and Goldhammer, Hill and Nachamkin are presented and compared with the existing experimental results for the levels at 3.69 MeV ($\frac{3}{2}^{-}$, $\frac{1}{2}$) 7.55 MeV ($\frac{5}{2}^{-}$, $\frac{1}{2}$) and 15.11 MeV ($\frac{5}{2}^{-}$, $\frac{3}{2}$). (auth)

17722 MUON CAPTURE RATE IN ^{16}O AND THE GROUND-STATE WAVE FUNCTION. Eriksinae, P.; Saarela, M.; Kallio, A. (Dept. of Theoretical Physics, Oulu, Finland). Phys. Lett.; 34B: 5-6(18 Jan 1971).

The effect of deformed components in ^{16}O ground-state wave function upon total μ-capture rate is studied. It is found that the discrepancy between theory and experiment is reduced to great extent both in group summation method and in closure approximation. (auth)

17723 LEVELS OF ^{10}B FROM ^{9}Be(p,d_0)^{9}Be, ^{9}Be(p,α_0)^{6}Li, AND ^{9}Be(p,α_1)^{6}Li* REACTIONS. Tu, Joseph Hoang Thanh. College Park, Md.; Univ. of Maryland (1969). 196p. University Microfilms Order No. 70-24,346.

Thesis.

Differential cross sections for ^{9}Be(p,d_0)^{9}Be and ^{9}Be(p,α_0)^{6}Li were measured at lab angles of 15, 30, 50, 70, 90, 110, 130, 150° at proton energy from 0.20 to 2.00 MeV corresponding to excitation of ^{10}B from 6.77 to 8.39 MeV. Differential cross sections for ^{9}Be(p,α_1)^{6}Li* were also obtained at 20, 30, 50, 70, 90, 110, 130, and 150° at proton energy from 1.1 to 2.5 MeV. The total cross sections for d_0 and α_0 exhibit definite peaks at 0.330, 0.450, 0.935 MeV superposed on a broad background. The α_1 total cross section shows a single 1-MeV broad peak centered at 1.8 MeV. Strongly energy-varying asymmetry in the background of both the d_0 and α_0 data indicate existence of broad interfering levels. The

data were analyzed using a "multi-level" R-matrix computer program, including all open channels, and incorporating both resonant and nonresonant effects. The latter originates from the distant-level term R^0 and simultaneously provides the correction of the usual hard-sphere phase-shifts through the diagonal elements of R^0 obtained by an optical model calculation and gives nonresonant reaction terms through its nondiagonal elements. These terms, although small by themselves, interfere strongly with the resonances. They also provide a reasonable fit to the reaction cross-sections at higher energies which exhibit a marked "direct" character. Analysis was made extremely complicated by the fact that little was previously known about the levels involved, even their existence. The following conclusions are based on a consistent set of levels and their characteristics which give a good fit to all the data. Nine levels were included. These are at E_p = 0.325, 0.375, 0.450, 0.650, 0.960, 1.10, 1.29, 1.55, 1.80 with respective $J\pi$ of 1^-, 1^+, 2^-, 1^-, 3^+, 2^-, 1^+, 2^+, and Γ of 125, 110, 89, 425, 135, 200, 220, 370, 1100 keV. Of these the 0.325, 0.96, 1.29 levels have been seen by proton elastic scattering and radiative capture. The other levels which are postulated here in order to fit the present data, should show up in $^6Li(\alpha,\alpha)^6Li$ or $^6Li(\alpha,\gamma)^{10}B$, or in $^{10}B(d,d')$. Furthermore, the levels at 0.65, 1.55, 1.80 might also be checked by $^9Be(p,\gamma)$ or $^9Be(p,p)$ since the proton widths are not too small. (Diss. Abstr. Int., B)

17724 VECTOR ANALYSING POWER OF THE PICK-UP REACTION $^{12}C(d,t)^{12}C$. Debenham, A. A.; Griffith, J. A. R.; Irshad, M.; Roman, S. (Univ. of Brimingham, Eng.). Nucl. Phys.; A160: 649-53(1971).

The vector analyzing power was measured for the reaction $^{13}C(d,t)^{12}C$ initiated by 12.1-MeV polarized deuterons and proceeding to the ground and 4.43-MeV states of ^{12}C. Large analyzing powers were observed especially for the ground-state reaction. The results are compared with the predictions of the distorted-wave Born approximation and with data for the $^{12}C(d,p)^{13}C$ reaction. (auth)

17725 THE d-^{12}C OPTICAL POTENTIAL BELOW 12 MeV. Wilsch, H.; Clausnitzer, G. (Univ., Erlangen, Ger.). Nucl. Phys.; A160: 609-17(1971).

The analyzing power of ^{12}C for the elastic scattering of vector-polarized deuterons at 9, 10, 11, and 12.0 MeV is measured. A simultaneous optical-model analysis of the cross section and analyzing power shows clearly that there is no reasonable optical potential of the usual form in this energy region. (auth)

17726 COLLECTIVE NATURE OF THE LOW-LYING STATES IN ^{27}Al AND ^{23}Na INVESTIGATED WITH (p,α) REACTIONS. Philipp, G.; Emmerich, W.-D.; Hofmann, A.; Kroner, G.; Thomas, K. (Univ., Erlangen, Ger.). Nucl. Phys.; A160: 654-64(1971).

A tandem Van de Graaff accelerator was used to study (p,α) reactions with the target nuclei ^{31}P, ^{30}Si, ^{27}Al, and ^{26}Mg. At bombarding energies between 5.8 and 8.2 MeV and between 10 and 11.5 MeV differential cross sections for the excitation of the low-lying states of the residual nuclei were measured. The spin dependence of the integrated cross sections and angular distributions are discussed using collective models. (auth)

17727 DEFORMATIONS OF LIGHT NUCLEI IN THE LOCAL DENSITY APPROXIMATION. Zofka, J.; Ripka, G. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett.; 34B: 10-12(18 Jan 1971).

The states of doubly even N = Z nuclei from ^{12}C to ^{40}Ca are calculated in Hartree–Fock theory using the density-dependent effective interaction of Negele. The results are compared to those obtained with the effective interaction of Brink and Boeker. (auth)

17728 NUCLEAR BREMSSTRAHLUNG FROM A SPIN-ZERO TARGET. Dale, C.; Strobel, G. L. (Univ. of Georgia, Athens). Nucl. Phys.; A156: 600-8(1970).

From Low's theorem the low-energy limit of the bremsstrahlung amplitudes can be calculated from the corresponding elastic scattering cross section. This was applied to proton bombardment of ^{12}C. The results gave a differential cross section that agreed quantitatively with the experimental data for bremsstrahlung induced by 140-MeV lab energy protons on ^{12}C. (auth)

17729 CONTINUUM CALCULATION OF THE ^{12}C PHOTODISINTEGRATION LEADING TO LOW-LYING MASS-11 STATES. Birkholz, J. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett.; 34B: 1-4(18 Jan 1971).

The shell-model approach to nuclear reactions is applied to the photonuclear giant resonance of ^{12}C. A separable approximation method is presented and its accuracy is tested. The characteristic features of the (γ,n) and (γ,p) cross sections are fairly well described by taking into account the low-lying excited states of the residual mass-11 system. (auth)

17730 OPEN-SHELL RANDOM-PHASE APPROXIMATION AND THE NEGATIVE PARITY EXCITATIONS OF ^{12}C. Rowe, D. J.; Wong, S. S. M. (Univ. of Toronto). Nucl. Phys.; A153: 561-85(1970).

The equations-of-motion formalism was used to extend the RPA (random-phase approximation) to the negative parity excitations of open-shell nuclei. Thus the open-shell RPA extends the simple microscopic description of collective vibrations to non-simple nuclei and renders a whole new range of nuclei accessible to microscopic theoretical investigation. As a simple example, the model is applied to describe the negative parity excitations of ^{12}C based on an uncorrelated ground state taken from a shell-model calculation within the $1p_{\frac{3}{2}}$ and $1p_{\frac{1}{2}}$ subshells. Comparison is made with the (much less realistic) standard RPA for which the uncorrelated ground state is taken to be the closed $1p_{\frac{3}{2}}$ sub-shell. (auth)

17731 DEUTERON INDUCED REACTIONS ON ^{13}C. Liebenauer, Paul Henry. Cleveland; Case Western Reserve Univ. (1970). 78p. University Microfilms Order No. 70-25,888.

Thesis.

Excitation functions and angular distributions were obtained for most of the kinematically available exit channels from the ^{13}C + d system. Excitation functions in the energy interval 1.0 to 2.7 MeV were obtained at selected angles for the following: $^{13}C(d,p_0)^{14}C$ (g.s.), $^{13}C(d,p_1)^{14}C$ (6.09 MeV), $^{13}C(d,p_3)^{14}C$ (6.72 MeV), $^{13}C(d,p_4)^{14}C$ (6.89 MeV), $^{13}C(d,d)^{13}C$ (elastic), $^{13}C(d,t_0)^{12}C$ (g.s.), $^{13}C(d,\alpha_0)^{11}B$ (g.s.), $^{13}C(d,\alpha_1)^{11}B$ (2.14 MeV), and $^{13}C(d,\alpha_2)^{11}B$ (4.46 MeV). Angular distributions in the angular range 20 to 160° were obtained at selected energies for the following: $^{13}C(d,p_0)^{14}C$ (g.s.), $^{13}C(d,p_3)^{14}C$ (6.72 MeV), $^{13}C(d,p_4)^{14}C$ (6.89 MeV), $^{13}C(d,t_0)^{12}C$ (g.s.), $^{13}C(d,\alpha_0)^{11}B$ (g.s.), and $^{13}C(d,\alpha_1)^{11}B$ (2.14 MeV). The data show that the reaction mechanism does not proceed solely via compound nucleus, but that direct processes must be considered. Resonances in the excitation functions were used to obtain values for the energy levels in the compound nucleus, ^{15}N, in the range of excitation energies between 17.1 and 18.5 MeV. The results are in good agreement with previous work. (Diss. Abstr. Int., B)

17732 COULOMB ENERGY OF A = 6 NUCLEI. Alessandrini, V. A.; Avalos, D. R.; Epele, L. N.; Gregorio, M. A.; Fanchiotti, H. (Univ. Nacional, La Plata). Nucl. Phys.; A150: 273-81(1970).

The binding energy of the 3.562-MeV excited state of ^{6}Li, which belongs to an isotopic triplet together with the ground state of ^{6}He and the (unstable) nucleus ^{6}Be, is computed by introducing Coulomb effects in a three-body model of ^{6}He. The calculation is carried out in the framework of the Faddeev–Lovelace equations, and the results obtained are in excellent agreement with experiments. (auth)

17733 COMMENT ON THE ISOSPIN-NONCONSERVING REACTION $^{12}C(d,\alpha)^{10}B(0^+,T=1)$. Weller, H. R. (Univ. of Florida, Gainesville). Phys. Rev., C; 2: 321-2(Jul 1970).

The second-order ^{6}Li mechanism proposed by Noble can account for the recent observation of fine structure if the $^6Li^*$ and ^{8}Be nuclei are coupled to states of definite J^π. (auth)

17734 SEQUENTIAL DECAY IN THE $^7Li(\alpha,t)^8Be(\alpha)^4He$ AND $^7Li(\alpha,\alpha')^7Li^*(t)^4He$ REACTIONS AT E_α = 50 MeV. Lambert, J. M.; Treado, P. A.; Beach, L. A.; Theus, R. B.; Petersen, E. L. (Naval Research Lab., Washington, D. C.). Nucl. Phys., A152: 516-28(1970).

The $^7Li(\alpha,t)^8Be(\alpha)^4He$ and $^7Li(\alpha,\alpha')^7Li^*(t)^4He$ reactions have been observed in a kinematically complete experiment with E_α = 50 MeV, particle identification, and on-line computer coincidence electronics. Sequential decay through the ground, 2.9, 11.4, 16.6 and 16.9, and 19.9 MeV states of ^{8}Be and the 4.63 and 7.48 MeV states of ^{7}Li has been observed. Triton angular distributions for the decay through the ground state of ^{8}Be were obtained with and without coincidence requirements. Agreement of these distributions implies isotropic decay in the c.m. of the ^{8}Be ground state. The contribution of quasi-elastic processes is small due to the specific limited portion of phase space observed. (auth)

17735 EXCITATION FUNCTIONS OF PROTON-INDUCED REACTIONS ON OXYGEN AT MEDIUM ENERGIES. Bunker, Stephen Norbert. Los Angeles; Univ. of California (1970). 160p. University Microfilms Order No. 70-19,835.

Thesis.

Elastic and inelastic protons scattered from ^{16}O were observed at laboratory angles between 60 and 160° with NaI(Tl) detectors. The incident beam energy was varied in approximately 200 keV steps from 21.25 to 33.12 MeV and in 500 keV steps at higher energies up to 38.50 MeV. Angular distributions at the same energies were also taken for inelastic scattering with Q = –6.05, –6.13 MeV (doublet), and Q = –8.88 MeV. The excitation functions for the (p,d) and (p,α) reactions were measured at 70° for the same energy range, and the (p,t) reaction was observed above 31 MeV. The elastic data are partially integrated over the angular range 100 to 160°. Several peaks are observed both in the normal exci-

tation functions and in the integrated curves. These peaks exist with varying magnitudes in most of the reaction channels studied. An optical-model-with-resonance analysis of the data is presented, which indicates states at E_p = 21.6, 22.6, 23.5, 24.7, 26.4, 28.3, and 30.1 MeV with J^π assignments of $^9/_2^+$, $^9/_2^+$, $^7/_2^+$, $^7/_2^+$, $^7/_2^-$, $^5/_2^-$, and $^5/_2^+$. A coupled-channels calculation is also performed on the elastic and inelastic (Q = −6.05, −6.13 MeV) channels, which assumes coupling to a vibrational state. (Diss. Abstr. Int. B.)

17736 $^{15}N(p,\gamma_{1}\gamma)^{16}O$ AND THE DEFORMED GIANT RESONANCE IN ^{16}O. Barnett, A. R.; Lowe, J. (Univ. of Minnesota, Minneapolis). Phys. Rev. Lett.; 26: 266-9(1 Feb 1971).

The cascade γ-ray decay of states at 19.9 and 20.4 MeV in ^{16}O was observed using the reaction $^{15}N(p,\gamma_{1}\gamma)^{16}O$. These states appear to have the properties expected of giant dipole states based on the $J^\pi = 3^-$ state at 6.13 MeV. Together with earlier work, the result implies that giant dipole states based on the $J^\pi = 0^+$ state at 6.05 MeV are displaced significantly from the energies expected from a simple weak-coupling model. (auth)

17737 $^{16}O(\alpha,\gamma)^{20}Ne$ AND $^{28}Si(\alpha,\gamma)^{32}S$ REACTIONS AT LOW ENERGY. Toevs, James Waldo. Pasadena, Calif.; California Inst. of Tech. (1970). 136p. University Microfilms Order No. 70-18,047.

Thesis.

The $^{28}Si(\alpha,\gamma)^{32}S$ and $^{16}O(\alpha,\gamma)^{20}Ne$ reactions were investigated to provide data for the calculation of the stellar rates of these reactions. The gamma rays were counted with a NaI(Tl) detection system having a high detection efficiency which is approximately independent of the gamma-ray cascade structure of a nuclear level; the detection efficiency was determined experimentally. The reaction $^{28}Si(\alpha,\gamma)^{32}S$ was studied for He^+ bombarding energies from 1.4 to 2.7 MeV. In this region five new resonances were found; and their strengths, $(2J + 1)\Gamma_\alpha\Gamma_\gamma/\Gamma$, were measured. An upper limit for the cross section was also established for bombarding energies below 1.7 MeV. The $^{16}O(\alpha,\gamma)^{20}Ne$ reaction was investigated in the energy region from 0.85 to 1.8 MeV; strengths for the previously known resonances were measured, and an upper limit for the cross section was determined for energies below 1 MeV. Stellar interaction rates and photodisintegration rates are calculated from the measured resonance strengths, and semi-empirical fits to these rates are given to facilitate astrophysical calculations. (Diss. Abstr. Int. B.)

17738 NOVEL METHOD FOR THE MEASUREMENT OF EXCITATION FUNCTIONS FOR CHARGED-PARTICLE REACTIONS ON GASES. Rautenbach, W. L.; Steyn, J.; Richards, D.; Smith, H. J. (National Physical Research Lab., Pretoria). pp 365-72 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

Excitation functions are presented for the production of ^{18}F by irradiation of ^{16}O with 32 MeV α-particles and 35 MeV ^3He ions at the Pretoria cyclotron. The maximum measured cross-section for the production of ^{18}F by ^3He irradiation of oxygen was 380 mbarn at 7.7 MeV. The excitation curve for the production of ^{18}F by irradiation of oxygen with α-particles reached 120 mbarn at 31.5 MeV, and was still rising at this energy. The ^{18}F activity was determined absolutely by $4\pi-\beta\gamma$ coincidence measurements which were carried out directly on the aluminium catcher foils. The difficulties of using the "stacked layer" technique on gaseous elements were overcome by introducing the gas between a number of accurately-spaced thin metal foils. The foils also served to degrade the beam energy. Provided that the gas layers were thin enough, all the radioactive nuclei produced in the gas by a charged-particle beam passing through the stack were collected by recoil onto the foil situated in the forward direction. (auth) (UK)

17739 ELASTIC SCATTERING OF 166 MeV ALPHA PARTICLES. Brissaud, I.; Tatischeff, B. (Univ. Paris, Orsay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.85-6 (May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The elastic scattering of 166 MeV alpha particles on C, Si, Sn, and Pb was investigated. Optical potentials were calculated using effective alpha particle–nucleon interaction and matter distribution. This method was also used to study other experimental results, at lower energies. (auth) (France)

17740 SCATTERING OF 14 MeV POLARIZED NEUTRONS ON ^{12}C AND ^{16}O. Sene, R.; Delpierre, P.; Kahane, J.; De Crespin de Billy, M. (College de France, Paris). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.88-9(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The distribution of the asymmetry in the elastic scattering of 14.1 MeV polarized neutrons on C-12 and O-16 was measured and was interpreted using an optical potential. (France)

17741 STUDY OF THE FIRST EXCITED STATE OF ^{14}N FROM THE INELASTIC SCATTERING OF 24 MeV POLARIZED PROTONS. Escudie, J. L.; Tarrats, A. (CEA, Saclay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.94-5(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The inelastic scattering of polarized protons of 24 MeV on ^{14}N, leading to the first excited state was studied in order to investigate the effect of the tensor force. The analysis presently in progress uses a microscopic D.W.B.A. approach including charge exchange effects. (auth) (France)

17742 QUASI-ELASTIC SCATTERING OF HIGH ENERGY ELECTRONS ON ^{12}C. Berthot, J.; Bertin, P. Y.; Isabelle, D. B. (Univ., Clermont-Ferrand, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.106-7(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Energy spectra for quasi-elastic scattering were established for different kinematic conditions. The results are in good agreement with the shell model predictions. However, at least two structures were observed in the region of high-energy excitation. (auth) (France)

17743 MECHANISM OF REACTIONS $^6Li(\alpha,d)^8Be$ AND $^6Li(\alpha,p)^9Be$. Lefevre, C. (Univ., Grenoble, France); Deconninck, G.; Demortier, G.; Longequeue, N. J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.125-6(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Reactions at energies of 28, 32, 36 and 40 MeV, were studied. The results obtained indicate a mechanism of direct reaction between two alpha particles superposed on a diffraction mechanism. (France)

17744 MECHANISM OF (p,n) REACTIONS ON ^9Be. Deconninck, G.; Bodart, F. (Centre de Physique Nucleaire, Louvain, Belg.). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.127-8(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The neutrons emitted in these reactions may arise from diverse mechanisms. Measurements were made in the 2.8 to 4.1 MeV range. The angular distributions of the neutron spectra were obtained at six different energies using time-of-flight measurements. (France)

17745 INTERACTION OF FAST NEUTRONS WITH ^{12}C. Deconninck, G.; Meulders, J. P. (Centre de Physique Nucleaire, Louvain, Belg.). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.129-30(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Elastic and inelastic scattering cross sections of neutrons on ^{12}C were measured between 14 and 20 MeV. Good fits were obtained at 18 MeV with standard optical model parameters and the giant resonance at E_n = 19.6 MeV was studied with a coherent interference mechanism between the potential and the resonant scattering. (auth) (France)

17746 MECHANISM OF (t,d) REACTIONS ON ^6Li, ^9Be, AND ^{10}B WITH TRITON ENERGIES UP TO 3.5 MeV. Bing, O.; Seltz, R.; Gerardin, C.; Wery, M. (CNRS, Strasbourg). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.142-3(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Differential cross sections were measured between 1.5 and 3.5 MeV for the $^6Li(t,d)^7Li$, $^9Be(t,d)^{10}Be$ and $^{10}B(t,d)^{11}B$ reactions going to the ground states of residual nuclei. D.W.B.A. calculations provided satisfactory fits to the ^6Li and ^9Be reactions. For the $^{10}B(t,d)^{11}B$ reaction a single stripping mechanism was unable to explain the large backward peak. (auth) (France)

17747 STUDY OF THE $^{10}B(t,\alpha)^9Be^*$ REACTION INDUCED BY TRITONS WITH ENERGIES UP TO 3.5 MeV. Gerardin, C.; Seltz, R.; Wery, M. (CNRS, Strasbourg). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.144-5(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Differential cross sections were measured between 1.5 and 3.5

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MeV for the $^{10}B(t,\alpha)^{9}Be$ reaction going to the ground state and the 1.75, 2.43 and 3.03 MeV states of ^{9}Be. Most of these reactions proceed predominantly by direct interaction. D.W.B.A. calculation results for pickup are given and discussed. The reaction giving the negative parity states of ^{9}Be apparently proceed by an other direct mechanism. The fit for the 1.75 MeV ($1/2^+$) level is consistent with a $^{8}Be + p + n$ configuration of ^{10}B. (auth) (France)

17748 STUDY OF $^{9}Be(d,p_0)^{10}Be$ AND $^{9}Be(d,t_0)^{8}Be$ REACTIONS FROM 0.24 TO 3.8 MeV. Scheurer, J. N.; Berrada, M.; Frois, B.; (and others) (Univ. Bordeaux, Gradignan, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.146-7(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The reactions (d,p_0) and (d,t_0) on ^{9}Be were studied from 240 keV to 3.8 MeV. Angular distributions are given for 240 keV, 2.2 MeV and 3.8 MeV. The reaction (d,p_0) is analyzed in terms of D.W.B.A. theory. (auth) (France)

17749 STUDY OF $^{11}B(n,n'\gamma)$ REACTIONS. Haouat, G.; Lachkar, J.; Patin, Y.; Sigaud, J. (CEA, Montrouge, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.148-9(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The angular distribution of photons following the $^{11}B(n,n'\gamma)^{11}B$ reaction, at neutron energies of 7.18, 8.5 and 9.72 MeV, was studied; the first and the third energies correspond to compound nucleus resonance. The excitation function at 90° of these photons, was measured in the 4.8 to 9.7 MeV energy range. (auth) (France)

17750 RECOIL-DISTANCE MEASUREMENTS OF LIFE-TIMES. Frick, G.; Haas, F.; Heusch, B.; (and others) (CNRS, Strasbourg). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.158-9(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Recoil-distance measurements of lifetimes of excited states produced in the $^{10}B(\alpha,p)^{13}C$, $^{7}Li(\alpha,n)^{10}B$, $^{27}Al(\alpha,p)^{30}Si$ and $^{27}Al(\alpha,n)^{30}P$ reactions are reported. The mean lives obtained are as follows: 9.9 ± 0.9 ps for the 3.85 MeV level in ^{13}C, 2.15 ± 0.45 ps for ^{10}B (2.15 MeV), 24.2 ± 2.0 ps for ^{30}Si (3.79 MeV) and 55 ± 7 ps for ^{30}P (0.709 MeV). (auth) (France)

17751 MECHANISM OF THE $^{14}N(^{3}He,p)^{16}O$ REACTION AT 3 MeV. Meynadier, C.; Allab, M.; Allard, J. F.; Chambon, B.; Dumazet, G. (Institut d'Etudes Nucleaires, Algiers). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.160-1(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Differential cross-section measurements were made for the $^{14}N(^{3}He,p)^{16}O$ reaction at a bombarding energy of 3 MeV. Angular distributions of some proton groups suggesting a direct process were analyzed with the PWBA theory assuming a deuteron capture. The possible manifestation of the four-point graphs is discussed. (auth) (France)

17752 INTERACTION MECHANISM IN THE $^{11}B(p,\alpha)^{8}Be(0^+)$ REACTION. Cavaignac, J. F. (Univ., Grenoble, France); Longequeue, N.; Honda, T. J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.164-5(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The $^{11}B(p,\alpha)^{8}Be$ (0^+) reaction was studied at E_p = 12, 20, 24 and 30 MeV. A phase wave analysis taking account of the pickup and heavy particle pickup processes fits the experimental results fairly well. (auth) (France)

17753 T = 3/2 STATES IN (p,t) AND (p,^{3}He) REACTIONS ON ^{35}Cl AND ^{37}Cl. Bruandet, J. F.; Longequeue. N.; Longequeue, J. P.; Maillard, J. P.; Vignon, B. (Univ., enoble, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.166-7(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The ^{35}Cl and ^{37}Cl (p,t) and (p,^{3}He) reactions were studied using a 40 MeV proton beam. Isobaric analog states of final nuclei were observed. (auth) (France)

17754 EVIDENCE FOR THE 2p-1t STATES IN ^{17}O BY THE DOUBLE STRIPPING REACTION ON ^{15}N. Lemaire, M. C. (CEA, Saclay, France); Mermaz, M. C.; Seth, K. K.; Scheurer, J. N. J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.174-5 (May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The $^{15}N(^{3}He,p)^{17}O$ reaction was performed with the 18 MeV ^{3}He beam of the Saclay E.N. Van de Graaff Tandem accelerator. A D.W.B.A. angular distribution analysis using the Glendenning two-nucleon transfer formalism for the form factor calculation bears out clearly the general provisions of the Zuker shell model calculations of ^{17}O nucleus. (auth) (France)

17755 THREE-NUCLEON TRANSFER IN (^{6}Li,t) REACTIONS. Bassani, G.; Calamand, A.; Pappalardo, G.; (and others) (CEA, Saclay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.176-7(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The $^{13}C(^{6}Li,t)^{16}O$ and $^{12}C(^{6}Li,t)^{15}O$ reactions have been studied using the 28 MeV beam from the Saclay Tandem Van de Graaff. The angular distributions of the strongly excited states typically exhibit a pronounced forward peaking suggesting an important contribution from a direct reaction mechanism. (auth) (France)

17756 THREE-, FOUR-, AND FIVE-NUCLEON TRANSFER REACTIONS INDUCED BY HEAVY IONS. Roynette, J. C.; Colombani, P.; Jacmart, J. C.; (and others) (Univ. Paris, Orsay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.178-9 (May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Three-, four- and five-nucleon transfer reactions leading to ^{16}O residual nucleus were studied with ^{12}C, ^{16}O, ^{20}Ne beams, between 72 and 100 MeV. Excitation spectra show the population of final states of ^{16}O residual nucleus to be rather selective. (auth) (France)

17757 STUDY OF THE (p,2p) REACTION AT 600 MeV. Kullander, S. (European Organization for Nuclear Research, Geneva). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.182-3 (May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

At 600 MeV (p,2p) reactions were investigated with carbon, silicon, calcium, vanadium targets. 4×10^{6} events are recorded. Preliminary results on the inner shells and the momentum distributions are given. (auth) (France)

17758 STUDY OF THE DISTORTION IN $^{12}C(p,2p)^{11}B_{1p\frac{1}{2}}$ AND $^{40}Ca(p,2p)^{39}K_{2S\frac{1}{2}}$ IN COPLANAR AND NON-COPLANAR GEOMETRY AT 156 MeV. Hourany, E.; Yuasa, T.; Didelez, J. P.; (and others) (Univ. Paris, Orsay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.184-5(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The cross section of the symmetric (p,2p) reaction on ^{12}C and ^{40}Ca was measured with range telescopes, in coplanar and non-coplanar geometry, at 156 MeV. The interpretation is done in the simple impulse approximation and in D W I A using an optical potential deduced from the elastic proton scattering. (auth) (France)

17759 QUASI-ELASTIC SCATTERING ON NUCLEON CLUSTERS IN ^{7}Li AND ^{12}C AT 156 MeV. Bachelier, D.; Brussel, M. K.; Radvanyi, P.; (and others) (Univ. Paris, Orsay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.188-9(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The quasi-elastic scattering reaction (p,pt) on ^{7}Li was studied at 156 MeV; the angular correlation has the shape typical of a $L \neq 0$ (2P) momentum distribution. Probabilities of clustering corresponding to the parentages $^{7}Li \rightarrow t + \alpha$, $^{6}Li \rightarrow d + \alpha$ and $^{6}Li \rightarrow t + {}^{3}He$ are compared. (auth) (France)

17760 $(\alpha,2\alpha)$ REACTION ON ^{6}Li, ^{7}Li, ^{9}Be, ^{12}C AND ^{16}O AT 55 MeV. Pizzi, J. R.; Gaillard, M.; Gaillard, P.; (and others) (Univ., Lyon). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C.192-3(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The $(\alpha,2\alpha)$ reaction was studied at 55 MeV in order to test the mechanism of quasi-elastic scattering of alpha particles by the alpha clusters of the target nuclei. The results obtained on ^{6}Li, ^{7}Li and ^{9}Be are in agreement with this mechanism. The preliminary results on ^{12}C and ^{16}O show the mechanism is more complicated for these nuclei. (auth) (France)

17761 STUDY OF THE (α,α') AND $(\alpha,2\alpha)$ MECHANISM OCCURRING IN THE REACTION $\alpha + {}^{12}C \rightarrow 4\alpha$ AT 90 MeV. Jacquot, C.; Sakamoto, Y.; Jung, M.; Girardin, L.; Braun, H. (Univ.,

Strasbourg). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.199-200(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The breakup of ^{12}C into three α particles by 90 MeV incident α particles was observed. The events with two energetic α particles are analyzed by using the α cluster model of ^{12}C. The excitation energy spectrum and the recoil momentum distribution of the residual nucleus ^{8}Be were studied. The three α particles with small energies are plotted in the Dalitz diagram to get information about the spin and the parity of the excited states of ^{12}C. (auth) (France)

17762 REACTIONS $^{22}Ne(p,p)$ AND $^{22}Ne(p,p')$. ANALOG STATE OF THE NINTH EXCITED STATE OF ^{22}Ne IN ^{23}Na. Rihet, Y.; Beaumevieille, H.; Dumazet, G.; Lambert, M.; Meynadier, C. (Institut d'Etudes Nucleaires, Algiers). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.209-10(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The differential cross sections of $^{22}Ne(p,p)$ and $^{22}Ne(p,p')$ reactions were measured from 2.4 to 3.2 MeV, at eleven different angles, in 4 keV steps. An isobaric analog state of $^{23}Ne^*$ (E_{ex} = 3.99 MeV) in ^{23}Na is suggested at E_{ex} = 11.85 MeV (E_p = 3.2 MeV). (auth) (France)

17763 SPIN AND PARITY OF THE ^{12}C EXCITED STATE AT 18.36 MeV FROM THE $^{11}B(p,p)$ REACTION. Chanut, Y.; Beaumevieille, H.; Drain, D.; Meynadier, C.; Rihet, Y. (Institut d'Etudes Nucleaires, Algiers). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.211-12(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Excitation functions were measured for elastic scattering of protons from ^{11}B at proton energies from 1.1 to 3 MeV and at seven angles from 43 to 166° (C.M.). An analysis of the data indicates a spin-parity assignment of 3^- for the 18.36 MeV level in ^{12}C formed at the 2.62 MeV resonance. (auth) (France)

17764 STUDY OF THE ^{8}Be LEVELS FROM $^{4}He(\alpha,\alpha)$ SCATTERING IN THE FRAME OF THE THEORY OF RESONANCES WITH COMPLEX ENERGY. Tsan Ung Chan (Univ., Grenoble, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.219-20(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Levels schemes of ^{8}Be in the energy range 22 to 27 MeV are examined in the frame of Humblet–Rosenfeld complex eigenvalue theory of nuclear reaction by the analysis of the scattering ^{4}He (α,α). (auth) (France)

17765 MECHANISM OF $^{9}Be(p,p')^{9}Be$ AND $^{9}Be(p,\alpha_0)^{6}Li$ REACTIONS AT LOW ENERGY. Bontemps, A.; Longequeue, N.; Ligeon, E.; Cavaignac, J. F. (CEA, Grenoble, France. Univ., Grenoble, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.221-2(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The low energy reactions $^{9}Be(p,p)$ and $^{9}Be(p,\alpha)$ were studied. The elastic scattering was analyzed with a compound nucleus formalism, the (p,α) reaction with a theory of interference between a direct knock on mechanism and a resonance ($J^\pi = 2^-$). (auth) (France)

17766 DECAY OF ^{12}C INTO THREE ALPHA PARTICLES. Giorni, A.; Kong, A.; Siou, D. (Univ., Grenoble, France. CEA, Grenoble, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.223-4(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The $^{11}B + p \rightarrow {}^{12}C \rightarrow 3\alpha$ reaction was studied at E_p = 0.163, 0.68, 1.4 and 2 MeV. A calculation in which the reaction amplitude including the formation of a compound nucleus of ^{12}C and $\alpha-\alpha$ final state interactions is compared to the results. The sequential decay with only one $\alpha-\alpha$ interaction gives a good description of the experimental results. However, the calculations and experimental results are not in a good agreement for the 0^+ level of the ^{12}C nucleus because, in this region, the 0^+, 1^- and 3^- levels are in interference. (auth) (France)

17767 STUDY OF THE DECAY MODES OF THE ^{9}Li NUCLEUS. Chen, Yu-ssu. Pasadena, Calif.; California Inst. of Tech. (1970). 96p. University Microfilms Order No. 70-20,644.

Thesis.

The beta decay of the ^{9}Li nucleus and the subsequent particle decays of the unbound states of the ^{9}Be nucleus were investigated with two complementary techniques—the recoil-particle method and the beta-neutron coincidence method. ^{9}Li nuclei were produced by the $^{18}O(^{7}Li,^{9}Li)^{16}O$ reaction with a 20 MeV bombarding energy and by the $t(^{7}Li,^{9}Li)p$ reaction with a 14 MeV bombarding energy. The energy spectrum of the delayed alphas and the time-of-flight spectrum of the delayed neutrons were obtained. The half-life was also measured and was found to be 177 ± 3 msec. Besides the known decay branches to the ground state and to the 2.43 MeV state in ^{9}Be, a new decay branch to an unbound state in ^{9}Be at an excitation energy of 2.78 ± 0.125 MeV was observed. The branching ratios and the log ft values were found to be; (65.0)%, (32.0)%, (3.0)% and (5.12), (5.00) (5.97) to the ground state, the 2.43 MeV and the 2.78 MeV states, respectively. The observed properties of the 2.78 MeV state favor an assignment of $\frac{1}{2}^-$. It decays mainly by p-wave neutron emission to the ground state of ^{8}Be and has center-of-mass width of 1.1 ± 0.125 MeV. The fraction of the decays of the 2.43 MeV state in ^{9}Be involving emission of an f-wave neutron to the ground state of ^{8}Be was found to be (6.4 ± 1.2)%. (Diss. Abstr. Int., B)

17768 EXISTENCE OF A LEVEL OF ^{13}C AT E = 10.82 MeV. Meynadier, C.; Chanut, Y.; Drain, D. (Institut d'Etudes Nucleaires, Algiers). Lett. Nuovo Cim.; 4: 1063-7(5 Dec 1970). (In French).

The presence of two excited levels of ^{13}C at 10.76 ± 0.01 and 10.82 ± 0.01 MeV is shown with certitude. Also, the widths of some levels of ^{13}C are stated precisely. The reaction $^{11}B(^{3}He,p)^{13}C$ at an incident energy of 3 MeV was studied using a gaseous target of isotopic boron and a good-resolution detection system. (J.F.P.)

17769 THREE-ALPHA FINAL STATE INTERACTIONS. McMahan, C. Alex; Duck, Ian M. (Rice Univ., Houston, Tex.). Nucl. Phys.; A157: 417-34(1970).

A soluble model of the decay of a 2^+ particle into three identical strongly interacting 0^+ particles was used to investigate the reaction $^{11}B(p,\alpha)2\alpha$ at a proton energy of 2.65 MeV through the 18.37 MeV state of ^{12}C. The strong final state interactions are described by Faddeev equations with separable two-body interactions to represent the ground and first excited states of ^{8}Be. It is necessary to use a mixed ^{12}C initial configuration to reproduce the experimentally observed interference effects. A fit to the data requires the approximate inclusion of the Coulomb phase shifts. The decay is dominated by final state interactions with little evidence for direct three-body decay. (auth)

17770 ELASTIC ELECTRON SCATTERING FROM ^{13}C. Heisenberg, J.; McCarthy, J. S.; Sick, I. (Stanford Univ., Calif.). Nucl. Phys.; A157: 435-48(1970).

Cross sections for elastic scattering of electrons from the charge and magnetic distribution of ^{13}C were measured. The data, covering a range of q of 0.4 to 3.4 fm^{-1} are fitted by a phenomenological charge distribution. The difference between ^{12}C and ^{13}C is analyzed in terms of the change in parameters of the Woods–Saxon potential used in a shell-model description of the nuclei. (auth)

17771 TRANSFER REACTIONS LEADING TO STATES OF ^{11}C. Bohne, W.; Bommer, J.; Fuchs, H.; (and others) (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys.; A157: 593-608(1970).

The stripping reactions $^{10}B(d,n)^{11}C$ and $^{10}B(\tau,d)^{11}C$ were studied at 5.8 and 11.0 MeV, respectively. The reaction $^{12}C(\tau,\alpha)^{11}C$ was investigated at 9.5, 10.5, and 11.5 MeV. The results are described by DWBA and spectroscopic factors are extracted, where possible. Comparison of the different reactions yields estimates of the inherent uncertainty of the procedure. While the (d,n) and (τ,d) reactions are largely direct and yield spectroscopic information, the $^{12}C(\tau,\alpha)$ reaction exhibits interference of more complicated reaction mechanisms. The spins of ^{11}C levels at 8.65 MeV and 8.69 MeV were determined to be $\frac{5}{2}$ or $\frac{7}{2}$. (auth)

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Refer also to abstracts 17403, 17642, 17710, 17726, 17727, 17737, 17739, 17750, 17757, 17758, 17891, 17896, 17914, 17919, 17932, 17958, 17960, 17967, 18012, and 18019.

17772 (AD-712083) EXCITATION OF PARTICLE-HOLE STATES IN ^{28}Si BY INELASTIC ELECTRON SCATTERING AT HIGH MOMENTUM TRANSFER. Sick, I.; Donnelly, T. W. Jr.; Walecka, J. D.; Walker, G. E. (Stanford Univ., Calif. High-Energy Physics Lab.). Aug 1970. Contracts Nonr-225(67); F44620-68-C-0075. 16p. (HEPL-638; ITP-364). NTIS.

The predictions of the particle-hole model for ^{28}Si are compared with experimental results for large-angle high-momentum-

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transfer inelastic electron scattering. A few high-spin T = 1 states are seen to dominate the cross section. (auth) (USGRDR)

17773 (LYCEN-7074) ^{54}Fe(d,α) REACTION AT 28 MeV. Guichard, A.; Chevallier, M.; Gaillard, P.; Grossiord, J.-Y.; Gusakow, M.; Pizzi, J-R.; Ruhla, C. (Lyon Univ. (France). Institut de Physique Nucleaire). Nov 1970. 21p. (In French). Dep. NTIS (U. S. Sales Only).

Deuterons accelerated to 28 MeV were used to investigate the ^{54}Fe(d,α) reaction. Angular distributions, for excitation energies up to about 4.5 MeV, were obtained. D.W.B.A. calculations were made on the basis of the Glendenning two-nucleon transfer theory. The results provide information about two-hole states of ^{52}Mn. (France)

17774 (NP-18623) APPARATUS FOR HIGH-RESOLUTION DETECTION OF CHARGED PARTICLES: APPLICATION TO STUDY OF THE 1st T = 2 STATE OF ^{32}S. Gales, Sydney (Paris Univ., Orsay (France)). 1970. 64p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The apparatus is an example of the use of developments in cooled high-resistivity surface-barrier junctions giving enhanced energy resolution. The equipment was used to study the first T = 2 state of ^{32}S. The following reactions were investigated: ^{31}P(p,γ)^{32}S, ^{31}P(p,p$_1$γ)^{31}P, ^{31}P(p,p$_2$γ)^{31}P, ^{31}P(p,α$_1$γ)^{28}Si, and ^{31}P(p,α$_0$)^{28}Si. In addition, the ^{31}P(p,p$_0$)^{31}P reaction at incident energies of between 3.150 and 3.300 MeV was studied. The resonance E$_p$ = 3.189 ± 0.003 MeV possesses all the characteristics of the T = 2, ^{32}S level. (France)

17775 (ORNL-TM-3284) Al(n,xγ) REACTIONS FOR 5.3 ≤ E$_n$ ≤ 9.0 MeV. Dickens, J. K. (Oak Ridge National Lab., Tenn., 18 Jan 1971. Contract W-7405-eng-26. 38p. Dep. NTIS.

Interactions of neutrons with aluminum were studied by measuring gamma-ray-production cross sections. Spectra were obtained for incident mean neutron energies E$_n$ = 5.35, 5.85, 6.4, 6.9, 7.45, 7.95, 8.5, and 9.0 MeV. The gamma rays were detected using a coaxial Ge(Li) detector of 30 cm^3 active volume. Data were obtained for gamma-ray scattering angles of 55° for all E$_n$, for 90° for all E$_n$ except 5.35 MeV, and 75° for E$_n$ = 6.4 and 7.45 MeV. Time-of-flight was used with the detector to discriminate against pulses due to neutrons and background radiation. The gamma-ray spectra were reduced using a computer system based upon visual display of the data and estimation of the peak area using an interactive light pen. A simple algorithm which does not require a priori knowledge of the spectrum was used to estimate the underlying Compton distribution. Absolute cross sections for production of gamma rays were obtained for the incident neutron energies quoted above. The cross sections have been compared, where possible, with previous measurements with good agreement. The spectra were studied for gamma rays which could be associated with de-excitation of nuclear levels having unknown decay modes. Gamma rays were found having energies appropriate for ground-state decay of levels at excitation energies E$_x$ = 5.155, 5.414, 5.434, 6.514, 6.821, 6.956, 7.920, 7.411, 7.471, 7.56 (doublet), 7.655, 8.148, and 8.184 MeV. (auth)

17776 STUDY OF γ TRANSITIONS IN THE NUCLEI ^{40}K AND ^{28}Al. Freeman, R. M.; Gallmann, A. (Laboratoire de Physique Nucleaire et d'Instrumentation Nucleaire, Strasbourg). Nucl. Phys.; A156: 305-13(1970). (In French).

Gamma branching ratios in the nuclei ^{40}K and ^{28}Al were determined from particle-gamma coincidence measurements of the reactions ^{39}K(d,pγ)^{40}K and ^{27}Al(d,pγ)^{28}Al. In ^{40}K, results are given for only a few levels below 4 MeV that were excited with sufficient intensity. Some γ rays from ^{41}K(d,pγ)^{42}K were also seen. Decay schemes were obtained for most of the levels of ^{28}Al up to nearly 4 MeV excitation energy. The fifth excited state of ^{28}Al is shown to be a doublet separated by 2.9 ± 0.8 keV. (auth)

17777 LIFETIMES OF THE 3.79-MeV STATE OF ^{30}Si AND 0.709-MeV STATE OF ^{30}P. Haas, F.; Heusch, B.; Frick, G.; Gallmann, A.; Alburger, D. E. (Laboratoire de Physique Nucleaire et d'Instrumentation Nucleaire, Strasbourg). Nucl. Phys.; A156: 385-94(1970). (In French).

Recoil-distance measurements of lifetimes of excited states produced in the ^{27}Al(α,p)^{30}Si and ^{27}Al(α,n)^{30}P reactions are reported. The mean lives obtained are as follows: ^{30}Si, 3.79-MeV level, τ = 24.2 ± 2.0 ps and ^{30}P, 0.709-MeV level, τ = 55 ± 7 ps. These results are compared to previous measurements and theoretical predictions. (auth)

17778 PROTON SCATTERING AND THE OPTICAL MODEL DIFFERENCES BETWEEN ^{40}Ca AND ^{48}Ca. Maggiore, C. J.; Gruhn, C. R.; Kuo, T. Y. T.; Preedom, B. M. (Michigan State Univ., East Lansing). Phys. Lett.; 33B: 571-3(21 Dec 1970).

Elastic proton scattering from ^{48}Ca and ^{40}Ca was measured at 25, 30, 35 and 40 MeV. The rms radius determined by the optical model is 0.15 fm larger for ^{48}Ca than for ^{40}Ca, consistent with the $A^{\frac{1}{3}}$ law. (auth)

17779 SHELL MODEL CALCULATIONS FOR ^{34}Cl AND ^{38}K WITH THE MODIFIED SURFACE DELTA INTERACTION INCLUDING A TENSOR FORCE. Evers, D.; Stocker, W. (Univ., Muich). Phys. Lett.; 33B: 559-62(21 Dec 1970).

The effect of adding a tensor force to the MDSI is investigated for the low energy spectra of ^{34}Cl and ^{38}K, and for the transition rates involving J = 1$^+$ states in these nuclei. The model space includes the 2s$_{\frac{1}{2}}$, 1d$_{\frac{3}{2}}$ shells and 0 or 2 particles in the 1f$_{\frac{7}{2}}$ shell. (auth)

17780 STUDY OF THE REACTION (^{3}He,α) WITH SEVERAL S-D SHELL NUCLEI. McQueen, John Edmund Jr. Chapel Hill, N. C.; Univ. of North Carolina (1970). 103p. University Microfilms Order No. 70-21,212.

Thesis.

Using a 4 MeV Van de Graaff accelerator to produce an 8 MeV beam of doubly-ionized ^{3}He, angular distributions of ^{3}He particles elastically scattered from the nuclei ^{24}Mg, ^{26}Mg, ^{28}Si, ^{30}Si and ^{32}S were measured. Angular distributions were also obtained of the alpha particles resulting from the reactions ^{24}Mg(^{3}He,α)^{23}Mg, ^{26}Mg(^{3}He,α)^{25}Mg, ^{28}Si(^{3}He,α)^{27}Si, ^{30}Si(^{3}He,α)^{29}Si and ^{32}S(^{3}He,α)^{31}S. The Mg and Si targets were made from isotopically enriched oxides while an antimony sulfide target was used for sulfur. The scattered particles were collected in an array of 6 solid state surface barrier detectors and the pulses from these detectors were analyzed and processed by an on-line DDP-224 computer. Excitation curves were taken from 6.2 to 8.4 MeV for the (^{3}He,α) reaction on ^{24}Mg, ^{28}Si and ^{30}Si. These data were analyzed using the theory of Ericson fluctuations which indicated that the reaction was predominately (>80%) direct at angles less than 60 degrees. The elastic scattering data were fit with an optical model computer code and parameters for the entrance channel of a DWBA analysis were obtained. The DWBA calculations were made and compared to experiment and spectroscopic factors were extracted. Evidence was seen for a J-dependent effect in the l = 2 transfer processes which could not be produced in the theoretical calculations by the addition of a spin-orbit potential. The cross sections of the (^{3}He,α) reactions on ^{24}Mg, ^{28}Si and ^{32}S were found to be considerably larger than those for ^{26}Mg and ^{30}S. This is explained as being partially the result of the Q-value differences with the remaining difference attributed to reaction mechanisms other than the ordinary neutron pickup process. (Diss. Abstr. Int., B)

17781 COEXISTENCE IN ^{20}Ne, ^{22}Ne, AND ^{24}Mg. Strottman, Daniel. Stony Brook, N. Y.; State Univ. of New York (1969). 125p. University Microfilms Order No. 70-2485.

Thesis.

The effect of the mixing of multi-shell configurations is investigated in the sd shell nuclei ^{20}Ne, ^{22}Ne, and ^{24}Mg. E2 transition rates are calculated using wave functions obtained from a normal shell model calculation to determine where multi-shell configurations are important. Such discrepancies are qualitatively explained in ^{20}Ne and ^{24}Mg. Although the shell model correctly predicts the energy splitting of the ground state energy band in ^{20}Ne and the interband E2 transition rates, it fails to predict one of the two 0$^+$ states at 6.7 and 7.2 MeV and the rotational band based on it, and the 0$^+$ state at 8.7 MeV. It also misses by a factor of six the intraband transition from the 0$^+$ at 6.72 MeV to the 2$^+$ state at 1.63 MeV. Limiting the hole states to maximum weight in SU(3), two hole and four hole states in strong coupling are included, taking the unperturbed positions of the band heads as parameters. The hole states are lowered from their unperturbed positions by deforming the core. A small lack of overlap factor is included because deformation is expected to win out over the buildup of the matrix elements caused by including core polarization and pf-excitations correctly. The spins and parities of several states in the 9-11 MeV region are predicted as are E2 transition rates for all levels. Agreement is obtained only when the four hole state lies lower than the two hole state. An experiment is proposed to determine which of the two 0$^+$ states around 7-MeV is core excited. Recent shell model calculations in ^{22}Ne and ^{24}Mg have incorrectly given the splitting of the first two 2$^+$ states. By including pf^2 and pf^4 states, the ground state is lowered with respect to the K = 2 band. In ^{22}Ne the sd^{4}pf^2 configuration is taken to be (14 0); as the spin-orbit coupling badly breaks SU(3) symmetry, we also consider the state $|sd^4(80)L_1 \times f^2L_2, L>$. Inclusion of this configuration corrects for two-thirds of the discrepancy. Two hole states are not expected to play a large role in the relative band splitting. This is because the two hole state in strong coupling is (8 6) which has K = 0 and K = 2. Explicit calculations

show this to be true. The pf^2 and pf^4 configurations are also included in the ^{24}Mg basis. The pf^2 state helps correct for a small part of the discrepancy but other anomalies arise. The pf^4 configuration is shown to have little effect on the spectra. (Diss. Abstr. Int., B)

17782 BETA DECAY OF ^{58}Cu. Carlson, L. E.; Hutcheon, D. A.; Robertson, A. G.; (and others) (Nuclear Physics Lab., Oxford). Nucl. Phys.; A162: 35-41(1971).

The β^+ decay of the 1^+ ground state of ^{58}Cu to excited states of ^{58}Ni has been investigated by a study of the subsequent de-excitation γ-rays using a Ge(Li) detector. Branching ratios for positron transitions to the following ^{58}Ni states were obtained: 1.454 MeV (2^+), 2.0 ± 1.1%; 2.775 MeV (2^+), <0.22%; 2.902 MeV (1^+), 3.0 ± 1.2%; 2.943 MeV (0^+), 9.9 ± 1.6%; 3.038 MeV (2^+), 0.29 ± 0.09%; 3.263 MeV (2^+), 1.06 ± 0.14%; 3.531 MeV (0^+), <0.14%; 3.593 MeV (1^+), 0.67 ± 0.10%; and 3.898 MeV (2^+), <0.18%. Positive parity is assigned to the 2.902, 2.943, 3.263 and 3.593 MeV levels of ^{58}Ni and the log ft values deduced from the above branching ratios are compared to shell-model predictions. (auth)

17783 SPINS AND LIFETIMES OF SOME LOW-LYING STATES OF ^{58}Ni. Start, D. F. H.; Anderson, R.; Carlson, L. E.; Robertson, A. G.; Grace, M. A. (Nuclear Physics Lab., Oxford). Nucl. Phys.; A162: 49-70(1971).

Particle-gamma-ray angular correlation studies of the $^{58}Ni(p,p'\gamma)$ reaction have been used to determine the spins of the following states of ^{58}Ni: 2.775 MeV (2), 2.943 MeV (0), 3.038 MeV (1,2), 3.263 MeV (2), 3.420 MeV (3,4), 3.531 MeV (0), 3.593 MeV (1), 3.620 MeV (2,3,4), 3.774 MeV (2,3,4), and 4.108 MeV (2). Gamma-ray branching ratios and mixing ratios were also measured. The Doppler-shift attenuation method has been used to measure the lifetimes of the states of 2.902 MeV ($100^{+\infty}_{-88}$ fs) and 3.774 MeV ($400^{+\infty}_{-88}$ fs) while the mean life of the 2.943 MeV level was found to be 2.9 ± 0.1 ns by direct timing. The internal conversion coefficient of the 2.943 (0^+) MeV to 2.902 (1^+) MeV has been measured to be 0.48 ± 0.05 and an upper limit of 2% has been placed on the 2.943 MeV to ground state E0 transition. The experimental energy level spectrum of ^{58}Ni and electromagnetic transition rates are compared to shell-model predictions calculated using the two-body interaction matrix elements of Kuo. (auth)

17784 DECAY SCHEME STUDIES OF SHORT-LIVED ISOTOPES OF $69 \lesssim A \lesssim 88$ PRODUCED BY HEAVY-ION BOMBARDMENT. Doron, T. A.; Blann, M. (Univ. of Rochester, N. Y.). Nucl. Phys.; A161: 12-48(1971).

Sulfur-32 and ^{16}O ion beams were used to produce neutron deficient nucleides in the mass range $69 \lesssim A \lesssim 88$. Half-lives and energies of γ-rays following decay of these isotopes were measured. Isotopic assignments were made by combining cross bombardment techniques with compound nucleus evaporation calculations. Many assignments could be made by measuring the half-lives and excitation functions for individual γ-rays formed with a variety of target-projectile combinations. Several activities were found for which the assignments are ambiguous, although several likely assignments are suggested. (auth)

17785 STUDY OF ^{43}Sc STATES WITH PROTON TRANSFER REACTIONS ON ^{42}Ca. Bommer, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin); Grabisch, K.; Kluge, H.; (and others). Nucl. Phys.; A160: 577-601(1971).

The proton transfer reactions (d,n) and (^{3}He,d) on ^{42}Ca were studied. The reaction $^{42}Ca(d,n)^{43}Sc$ was studied by the time-of-flight method at deuteron energies between 5.0 and 6.05 MeV. The reaction $^{42}Ca(^3He,d)^{43}Sc$ was studied at 18.0 MeV with a magnetic spectrograph. Altogether 54 levels in ^{43}Sc up to an excitation energy of 6.92 MeV were identified including states at 4.234 and 6.145 MeV, which are T = ½ analogs of the $f_{7/2}$ ground state and the 2.048 MeV $p_{3/2}$ state, respectively, in ^{43}Ca. The l-values and spectroscopic strengths were determined for 31 transitions. Within the errors of the experiments and the DWBA analyses, the spectroscopic strengths derived from the (d,n) and the (^{3}He,d) experiments are in agreement for both T = ½ and T = ³/₂ states, i.e., there are no T-dependent discrepancies. Similar agreement is found in the strengths of the s- and d-hole transitions, which reflect the degree of particle–hole impurity in the $^{42}Ca_{g.s.}$ wave function. A second $\frac{1}{2}^+$ state is indicated at 2.657 MeV. It appears a likely candidate for the head of a second $K^\pi = \frac{1}{2}^+$ band of 6p–3h character as proposed by Johnstone. (auth)

17786 LOW-INTENSITY TRANSITIONS IN THE DECAY OF ^{88}Rb. Pratt, William W. (Pennsylvania State Univ., University Park). Nucl. Phys.; A160: 626-9(1971).

The γ rays following the decay of ^{88}Rb were studied with a 40-cm³ Ge(Li) detector with the aim of resolving discrepancies in some recent determinations of the decay scheme of this isotope. The existence of a 1799-keV γ ray was confirmed and three new γ rays with energies of 1218, 1295, and 1368 keV were found. All of these results are in good agreement with a decay scheme recently proposed by Ragaini and Knight. (auth)

17787 THE DECAY OF 23.0 MIN ^{79}Rb TO LEVELS IN ^{79}Kr. Lingeman, E. W. A.; de Boer, F. W. N.; Koldewijn, P.; Maurenzig, P. R. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys.; A160: 630-40(1971).

The radioactive decay of ^{79}Rb(23.0 ± 0.5 min) was studied with the aid of semiconductor radiation detectors. Both singles and coincidence spectra were recorded. The decay energy, 3520 ± 45 keV, was determined by measuring the endpoint of the positron spectrum in coincidence with prominent γ rays. A decay scheme is proposed incorporating most of the measured γ rays. The following energies in keV and parities of levels are assigned: ground state ($\frac{5}{2}^-$), 130.01 ± 0.12($\frac{1}{2}^+$), 147.3 ± 0.7($\frac{5}{2}^-$), 182.4 ± 0.5($\frac{3}{2}^+$), 291.4 ± 0.7($\frac{5}{2}^-$), 383.71 ± 0.18, 532.82 ± 0.33, 688.21 ± 0.09, 751.7 ± 0.7($\frac{5}{2}^-$), 934.0 ± 1.4, 1089.4 ± 0.4, 1474.7 ± 0.3. The spin and parity of the ^{79}Rb ground state are most probably $\frac{3}{2}^-$. (auth)

17788 ANALYSIS OF THE $^{35,37}Cl(p,t)$ AND $(p,^3He)$ REACTIONS TO MIRROR AND ANALOGUE STATES. Vignon, B. (Nuclear Physics Lab., Grenoble, France); Bruandet, J. F.; Longequeue, N.; Towner, I. S. Nucl. Phys.; A162: 82-96(1971).

The (p,t) and (p,^{3}He) reactions on $^{35,37}Cl$ are used to study the mirror and analog states in Cl and S isotopes. The T = ³/₂ states are identified at 5.55, 6.95, 7.35 and 8.10 MeV in ^{35}Cl and at 5.65 and 7.25 MeV in ^{35}Cl. Angular distributions for the strong transitions are obtained and analyzed using a zero-range DWBA theory. The ratio of (p,t) and (p,^{3}He) cross sections is within theoretical limits. Shell-model calculations in the model space $(2s_{1/2}, 1d_{3/2})^n$ have been carried out with four sets of two-body interaction matrix elements and the resulting level schemes and relative peak cross sections for (p,t) and (p,^{3}He) reactions are compared with experiment. Possible deficiencies in the model are discussed. (auth)

17789 PHOTOPRODUCTION OF CHARGED PIONS FROM NUCLEI. Blomqvist, I.; Nydahl, G.; Forkman, B. (Univ. of Lund, Sweden. Lund Inst. of Tech., Sweden). Nucl. Phys.; A162: 193-207(1971).

The yields of the reactions $^{41}K(\gamma,\pi^+)^{41}Ar$, $^{63}Cu(\gamma,\pi^+)^{63}Ni$, $^{88}Sr(\gamma,\pi^+)^{88}Rb$, and $^{138}Ba(\gamma,\pi^+)^{138}Cs$ were measured by activation analysis. Data on the reactions $^{11}B(\gamma,\pi^-)^{11}C$, $^{27}Al(\gamma,\pi^+)^{27}Mg$ and $^{51}V(\gamma,\pi^+)^{51}Ti$ obtained earlier were reanalyzed. The experimental cross sections are compared to predictions from simple model calculations. (auth)

17790 NUCLEAR MULTI CONFIGURATION HARTREE–FOCK CALCULATION. Faessler, A.; Plastino, A.; Schmid, K. W. (Univ., Muenster, Ger.). Phys. Lett.; 34B: 31-3(18 Jan 1971).

The Multi Configuration Hartree–Fock (MCHF) theory is applied to the ground state of ^{28}Si. The single particle basis states are the $0d_{5/2}$ and $1s_{1/2}$ orbitals. A comparison is made with the results of a Hartree–Fock calculation performed in the same space. (auth)

17791 PROTON HOLE STATES IN ^{20}F. Johnstone, I. P.; Castel, B.; Sostegno, P. (Queen's Univ., Kingston, Ont.). Phys. Lett.; 34B: 34-6(18 Jan 1971).

Proton hole states in ^{20}F are investigated by coupling $p_{1/2}$ and $p_{3/2}$ holes to states lying below 5 MeV in ^{21}Ne, using ^{21}Ne wave functions obtained from a band-mixing PHF calculation. (auth)

17792 INVESTIGATION OF THE DECAY $^{73}As \rightarrow {}^{73}Ge$. Kyles J.; McGeorge, J. C.; Shaikh, F.; Byrne, J. (Univ. of Edinburgh). Nucl. Phys.; A150: 143-60(1970).

The γ-ray, K x-ray, and conversion electron spectra produced by electron capture in ^{73}As were investigated using delayed coincidence techniques. Values of 0.57 ± 0.10 sec and 2.94 ± 0.04 μsec were derived for the half-lives of the 66.8 and 13.5 keV levels in ^{73}Ge. The transitions at 53.3 and 13.5 keV were confirmed to be M2 retarded and E2 enhanced, respectively. An attempt was made to interpret these results in terms of core excitation or cooperative properties of the nuclear levels. Results were also obtained for the K-capture fraction in ^{73}As and for the K-shell fluorescence yield in germanium. (auth)

17793 SCATTERING OF 19.5 MeV α-PARTICLES BY ^{62}Cu, ^{64}Ni, ^{65}Cu, AND ^{66}Zn. Ivascu, M.; Semenescu, G.; Bucurescu, D.; Titirici, M. (Inst. for Atomic Physics, Bucharest). Nucl. Phys.; A147: 107-19(1970).

A study of 19.5-MeV α-particle scattering by ^{62}Cu, ^{64}Ni, ^{65}Cu, and ^{66}Zn is presented. The elastic scattering angular distributions were analyzed with a parametrized phase-shift model and with the optical model. The inelastic scattering angular distributions to the first excited state were analyzed with the Austern–

Blair model and DWBA. Nonadiabatic effects were included in the Austern–Blair model calculations, and the results are similar to those of the DWBA. (auth)

17794 ANGULAR CORRELATION STUDIES OF THE ^{40}Ca $(pp'\gamma)^{40}$Ca REACTION. Sinex III, Charles Helm. Houston, Tex.; Rice Univ. (1970). 187p. University Microfilms Order No. 70-23,574.

Thesis.

Angular correlation and Doppler shift attenuation measurements were used to determine the gamma ray decay modes, spins, and lifetimes of excited states at 6.752 and 7.114 MeV in ^{40}Ca. These levels were populated by inelastic proton scattering in beam energies of 10 to 11 MeV with the inelastic proton detected in an annular counter placed 180° with respect to the beam axis. The gamma rays were detected in a 5″ × 5″ (NaI(Tl)) detector for the correlation measurements and in a 25 cm^3 Li–Ge detector for the lifetime measurements. The 6.752-MeV level was found to decay only to the 3$^-$ level at 3.737 MeV which decays only to the ground state. Two double correlation functions, $p'-\gamma_{3.0\,MeV}$ and $p'-\gamma_{3.7\,MeV}$ were measured. A second detector was added to this geometry (at 90° in the plane) and two triple correlation functions, $p'-\gamma(\theta)_{3.0\,MeV}-\gamma(90°)_{3.7\,MeV}$ and $p'-\gamma(90°)_{3.0\,MeV}-\gamma(\theta)_{3.7\,MeV}$ were measured. Analysis of these data yielded a unique spin assignment of 2 for the 6.75-MeV level. The lifetime was determined by observing the Doppler shift of the 3.0 MeV gamma ray at angles of 30° and 120° when detected in coincidence with inelastic protons from the 6.752 MeV level. The lifetime was found to be $205^{+80}_{-50} \times 10^{-13}$ seconds. The 7.114-MeV level was found to be a narrowly-separated doublet and new gamma ray decay modes are proposed for both members. One level decays mainly to the ground state of ^{40}Ca and double correlation measurements fix its spin as 2. The other level decays to the 3$^-$ level at 3.737 MeV and the 5$^-$ level at 4.491 MeV. Double correlation measurements fix its spin as 3 and branching ratios have been determined for its decay. Doppler shift measurements yield a lifetime of $234 \pm 64 \times 10^{-13}$ seconds for the 3.376 MeV gamma ray from this level. Extensions of angular correlation theory necessary for this work and a number of analysis programs for simultaneously fitting data from several different correlation measurements are described. (Diss. Abstr. Int., B)

17795 ELASTIC SCATTERING OF 1.12 MeV AND 1.33 MeV γ-RAYS THROUGH 90° AND 124.5° BY DIFFERENT ELEMENTS AND THE REAL PARTS OF THE DELBRUECK SCATTERING AMPLITUDES. Basavaraju, G.; Kane, P. P. (Indian Inst. of Tech., Bombay). Nucl. Phys.; A149: 49-62(1970).

The elastic scattering of 1.12- and 1.33-MeV γ rays by lead, mercury, tungsten, tantalum, silver, molybdenum, zirconium, and copper scatterers was studied at scattering angles of 90 and 124.5°. At the larger angle, the differential cross sections for heavy elements are significantly lower than the theoretical estimates made on the basis of a coherent addition of the nuclear Thomson and the atomic Rayleigh amplitudes. The Rayleigh amplitudes were determined by a slight modification of the procedure of Brown and Mayers. It is suggested that the lower values at 124.5° result from a destructive interference between the real Delbrück and Rayleigh amplitudes. The results at 90° do not reveal a significant Delbrück effect. The present results at 1.12 MeV and 1.33 MeV are in satisfactory agreement with many of the recent measurements at 1.12, 1.17, and 1.33 MeV. Results for tungsten, silver, molybdenum, and zirconium were not available earlier. (auth)

17796 (^{3}He,α) REACTION WITH NUCLEI IN THE s–d SHELL McQueen, J. E. Jr.; Joyce, J. M.; Ludwig, E. J. (Univ. of North Carolina, Chapel Hill. Triangle Universities Nuclear Lab., Durham, N. C.). Nucl. Phys.; A151: 295-316(1970).

Using 8-MeV ^{3}He particles, angular distributions of alpha particles were obtained resulting from the reactions ^{24}Mg(^{3}He,α)^{23}Mg, ^{26}Mg(^{3}He,α)^{25}Mg, ^{28}Si(^{3}He,α)^{27}Si, ^{30}Si(^{3}He,α)^{29}Si, and ^{32}S(^{3}He,α)^{31}S. Excitation function data were analyzed by applying the theory of Ericson fluctuations, which indicated that the reaction was predominantly direct (>80%) at the forward scattering angles. The ^{3}He parameters from elastic scattering analyses were incorporated in a DWBA analysis of the (^{3}He,α) reactions and spectroscopic factors were extracted. Evidence was seen for a J-dependent effect in the l = 2 transfer processes, which could not be produced in theoretical calculations by the addition of a spin-orbit potential. The cross sections of the (^{3}He,α) reactions on ^{24}Mg, ^{28}Si, and ^{32}S were found to be considerably larger than those on ^{26}Mg and ^{30}Si. This is explained as being partially the result of the Q-value differences with the remaining difference attributed to reaction mechanisms other than the ordinary neutron-pickup process. (auth)

17797 POSITIVE PARITY STATES IN ^{167}Er. Kanestroem, I.; Loevhoeiden, G. (Univ. of Oslo). Nucl. Phys.; A160: 665-72 (1971).

The positive parity states in ^{167}Er are described in terms of the rotational model, where the particle-rotation coupling is taken into account. The moment of inertia, the Fermi energy, and the coupling strength are determined by fitting the energies. The wave functions thus obtained are used to calculate the (d,p) stripping and (d,t) pick-up cross sections and branching ratios. The results obtained are in agreement with experimental data. (auth)

17798 RELATIVISTIC EFFECTS IN NUCLEAR MOTIONS. Braun, J. J.; Swamy, N. V. V. J. (Oklahoma State Univ., Stillwater). Nucl. Phys.; A160: 641-8(1971).

The wave functions of the relativistic equivalent harmonic oscillator recently proposed were used to calculate elastic electron scattering cross sections in the Born approximation for helium and lead. Calculations were also made with the nonrelativistic isotropic oscillator wave functions. Comparison with high-energy electron scattering experiments shows that relativistic effects may be significant in a heavy nucleus like lead. (auth)

17799 DECAY OF ^{164m}Ho AND ^{164g}Ho. Pathak, B. P.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys.; A160: 618-25(1971).

The disintegration characteristics of ^{164m}Ho and ^{164g}Ho were studied using a high-resolution Ge(Li) spectrometer. Radioactive samples of ^{164m}Ho and ^{164g}Ho were obtained through the (n, 2n) reaction on spectroscopically pure holmium oxide with 14-MeV neutrons. The isomeric cross-section ratio for the yields of the ground and metastable states was estimated to be 1.0 ± 0.25. Gamma rays of 37.7 and 56.1 keV energy were assigned to the decay of ^{164m}Ho, and 73.4- and 91.5-keV γ rays are attributed to the decay of ^{164g}Ho by electron capture and negaton emission, respectively. The branching ratio for the electron capture decay of ^{164g}Ho to the levels in ^{164}Dy was estimated accurately from the analysis of x-ray intensities. The results were incorporated into a decay scheme. (auth)

17800 INVESTIGATION OF PARITY MIXING IN ^{181}Ta AND ^{175}Lu BY MEASUREMENT OF THE CIRCULAR POLARIZATION OF γ-RAYS. Bock, P.; Jenschke, B. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys.; A160: 550-68(1971).

The circular polarization of the 482-keV γ radiation of ^{181}Ta and the 343-keV γ radiation of ^{175}Lu was measured with a Compton polarimeter. Spurious effects arising from higher-order contributions of quantum electrodynamics to the Compton scattering cross section were discovered. The results for the polarization are $P = -(4.1 \pm 1.3)10^{-6}$ for ^{181}Ta and $P = -(1.5 \pm 6.0)10^{-6}$ for ^{175}Lu. These values are corrected for instrument asymmetries, bremsstrahlung, and intensity of other lines. (auth)

17801 A STUDY OF THE LEVEL STRUCTURE IN ^{57}Fe FROM THE (d,p) REACTION ON ^{56}Fe. Sen Gupta, H. M. (Univ. of Dacca, Pakistan); Majumder, A. R.; Lin, E. K. Nucl. Phys.; A160: 529-49(1971).

The reaction ^{56}Fe(d,p)^{57}Fe is investigated at 12 MeV using the Aldermaston multichannel magnetic spectrograph. The angular distributions of protons leading to various states in ^{57}Fe up to an excitation of 6.7 MeV are measured over an angular range 5° to 175°. The data are analyzed with distorted-wave Born approximation calculations; a satisfactory agreement is found in most cases up to about 100°. Spin, parity, and spectroscopic factors for various states are obtained, and the positions of the single quasi-particle energies determined. The results are compared with those for the isotonic nuclei ^{55}Cr and ^{59}Ni and with the pairing theory. (auth)

17802 THE STRUCTURE OF ^{61}Co. Hudson, F. R. (Univ. of Bradford, Eng. Atomic Weapons Research Establishment, Aldermaston, Eng.); Glover, R. N. Nucl. Phys.; A160: 482-96 (1971).

The nucleus ^{61}Co was studied by the ^{59}Co(t,p)^{61}Co reaction supplemented by data from the ^{62}Ni(t,α)^{61}Co reaction. The level energies are in good agreement with existing data. States of spin $J = \frac{7}{2}^-$ are identified by L = 0 transitions in the ^{59}Co(t,p) reaction. By comparison with ^{62}Ni(t,α) data, significant $f_{\frac{5}{2}}$ admixture is deduced in the ^{62}Ni ground-state wave function. Correlation of existing ^{58}Fe(^{3}He,d)^{57}Co and ^{58}Ni(t,α)^{57}Co data also indicates $f_{\frac{5}{2}}$ admixture in the ^{58}Ni ground state. The (t,p) angular distributions show groups of L = 2 and L = 2 + 4 transitions as a function of excitation energy. This absence of L = 4 transitions when permitted by the selection rules provides information on the structure of the residual ^{61}Co states. (auth)

17803 DECAY OF ^{60}Co. Rice-Evans, Peter; Aung, Zin (London Univ.). Z. Phys.; 240: 392-5(1970).

The gamma spectrum from ^{60}Co decay was investigated with a 40-cc Ge(Li) detector. A peak at 822 keV is shown to be not a gamma transition but a single escape peak, and an upper limit of 10 is given to the branching ratio of the 2158-keV level. (auth)

17804 ELECTROMAGNETIC BRANCHING IN ^{65}Zn. Robert, K. Q.; Linn, J. R.; Pellegrini, B. J.; Durham, F. E. (Tulane Univ., New Orleans). Nucl. Phys.; A156: 553-60(1970).

The internal conversion coefficients of transitions between the low levels of ^{65}Zn populated in the ^{63}Cu(p,n)^{65}Zn* reaction were measured with an in-beam spectrometer at the E_p = 2.88 and 2.95 MeV isobaric analog resonances and at off-resonance energies. Angular distributions of the γ rays were measured at each energy with Ge(Li) detectors. Absolute neutron cross sections were derived and compared to theory. The values of α_K are: 54 keV: 6 ± 1; 61 keV: $(3 \pm 2) \times 10^{-1}$; 115 keV: $(5.8 \pm 0.5) \times 10^{-2}$; 153 keV: $(2.37 \pm 0.28) \times 10^{-2}$; 207 keV: $(2.05 \pm 0.30) \times 10^{-2}$. The mixing ratio of the 153 keV transition was deduced to be $\delta = 0.24 \pm 0.06$. These data are consistent with previous spin assignments of $J^\pi = 5/2^-$, $1/2^-$ and $3/2^-$ for the 0, 54 and 115 keV levels and establish the spin of the 207 keV level as $J^\pi = 3/2^-$. (auth)

17805 ROTATION-VIBRATION INTERACTION IN ^{27}Al. Roepke, H.; Glattes, V.; Hammel, G. (Univ., Freiburg i. B.). Nucl. Phys.; A156: 477-88(1970).

The existence of two γ-vibrational bands with $K = 5/2 \pm 2$ in ^{27}Al is proposed from a comparison with ^{25}Al and ^{25}Mg. The experimental evidence in favor of vibrational modes of excitation is discussed for these nuclei and also for ^{23}Na. In ^{27}Al a strong rotation-vibration interaction is indicated, which gives rise to the simultaneous appearance of both strong coupling and weak coupling features. In a rotation-vibration-interaction calculation of ^{27}Al, E2 transition strengths and inelastic scattering cross sections are fairly well reproduced. Difficulties arise in the interpretation of spectroscopic factors. (auth)

17806 EXPERIMENTAL STUDY OF THE DECAY OF ^{53}V. Dorikens-Vanpraet, L.; Dorikens, M.; Demuynck, J. (State Univ., Ghent). Z. Phys.; 241: 459-65(1971).

The decay of ^{53}V was investigated with a Ge(Li) spectrometer and gamma-gamma coincidence methods. Accurate energy, intensity and half-life determinations of 7 gamma rays were performed. These gamma rays fit in a level scheme with levels at 563.6, 1006.0, 1289.1, and 1536 keV. (auth)

17807 DIRECTIONAL CORRELATION OF SUCCESSIVE GAMMA-RAYS IN ^{60}Ni. Khan, Saghirun-Nisa; Chaudhry, Khalid Mahmud; Khan, Naeem Ahmad (Atomic Energy Centre, Lahore). Nucleus (Karachi); 6: 206-12(Oct-Dec 1969).

An experiment on gamma-gamma angular correlation employing 1.17- and 1.33-MeV gammas of ^{60}Ni and sodium iodide crystals as detectors is reported. The results obtained possess greater reliability and validity. (auth)

17808 CROSS SECTION FOR PAIR PRODUCTION IN Al, Cu, Cd, AND Pb AT 2.615-MeV γ-RAY ENERGY. Barkan, S. Meric (Univ. of Istanbul). Phys. Rev., A; 1: 1022-32(Apr 1970).

Cross sections for pair production by 2.615-MeV γ rays incident on Al, Cu, Cd, and Pb have been found by subtracting tabulated values of the photoelectric cross section from measured values of total cross sections. The latter were determined to be 129.8, 137.0, 147.6, and 181.9 mb per electron, respectively, for the above elements. The statistical uncertainty is ±0.2%. Subtraction of photoelectric cross sections gives 0.0642 (±5%), 0.343 (±2.3%), 0.991 (±1.4%), and 3.55 (±0.8%) b per atom for pair production. The present result in Pb is 38.9% higher than the Bethe-Heitler Born approximation result and is about 14% higher than Jaeger-Hulme non-Born theoretical results but only 6% higher than the recent, exact non-Born calculation (neglecting screening) by Øverbø, Mork, and Olsen. Differences between our values for Al, Cu, and Cd and the calculated values of these authors are even smaller, namely, 0.5% for Al and Cd, and 3% for Cu. It is pointed out that pair-production cross sections can be found from Born-approximation values by multiplication by $a + bZ$ for $0 < Z < 50$, with $a = 0.97 \pm 0.01$ and $b = 4 \times 10^{-3}$, and by a factor $1 + \alpha Z^2$ for $Z \geq 50$ with $\alpha = (5.8 \pm 0.1) \times 10^{-5}$. (auth)

17809 STROBOSCOPIC AND TIME-DIFFERENTIAL OBSERVATION OF THE NUCLEAR LARMOR PRECESSION ON THE 20 ms ISOMERIC STATE OF ^{71}Ge. Bertschat, H.; Christiansen, J.; Mahnke, H.-E.; Recknagel, E.; Schatz, G.; Sielemann, R.; Witthuhn, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys.; A150: 282-90(1970).

The methods of the stroboscopic observation of the nuclear Larmor precession as well as the conventional time-differential spin rotation were applied to a nuclear isomer in the millisecond region of lifetimes. The 20.2 msec state of ^{71}Ge was populated by the nuclear reaction ^{71}Ga(p,n). The uncorrected g-factor has been determined to be $g = -0.2304 \pm 0.0005$. (auth)

17810 INVESTIGATION OF ^{59}Co AND ^{61}Co USING THE ^{56}Fe $(\alpha,p\gamma)$ AND ^{64}Ni$(p,\alpha\gamma)$ REACTIONS. Coop, K. L.; Graham, I. G.; Titterton, E. W. (Australian National Univ., Canberra). Nucl. Phys.; A150: 346-68(1970).

The low-lying levels of ^{59}Co and ^{61}Co were investigated using particle-gamma coincidence techniques. Branching ratios were obtained for many states in ^{59}Co below 2.6-MeV excitation, and angular correlations involving several states were measured using the ^{56}Fe$(\alpha,p\gamma)$ reaction. From the correlation data involving transitions from the 1.744-MeV state, assignments of $9/2^-$ ($5/2^-$), $5/2$ and $7/2^-$ were made for the 1.190, 1.482, and 1.744 MeV states, respectively. The measured correlations involving the 1.100 and 1.291 MeV states were consistent with $3/2^-$ assignments for both. In ^{61}Co, the decay properties for many states below 2.3 MeV were determined. Probable spin assignments of $1/2$, $5/2$ or $3/2$ and $5/2$ or $3/2$ were deduced for the states at 1.623, 1.655 and 2.015 MeV, respectively. Systematics of the level structure of the odd-mass isotopes ^{57}Co, ^{59}Co and ^{61}Co were examined and many similarities noted. (auth)

17811 REORIENTATION MEASUREMENTS IN EVEN TITANIUM ISOTOPES. Haeusser, O.; Pelte, D.; Alexander, T. K.; Evans, H. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys.; A150: 417-38(1970).

The first excited 2^+ states in ^{46,48,50}Ti were Coulomb excited using beams of ^{35}Cl and ^{32}S. The results are interpreted in terms of the reorientation effect and yield static quadrupole moments $Q(^{46}\text{Ti}, 889\text{ keV}) = -0.19 \pm 0.10$ b, $Q(^{48}\text{Ti}, 983\text{ keV}) = -0.22 \pm 0.08$ b and $Q(^{50}\text{Ti}, 1550\text{ keV}) = -0.02 \pm 0.09$ b. The B(E2) $(0^+ \rightarrow 2^+)$ values were determined to be $0.107 \pm 0.010\ e^2 \cdot b^2$, $0.069 \pm 0.006\ e^2 \cdot b^2$ and $0.033 \pm 0.003\ e^2 \cdot b^2$, respectively. The results are compared with recent Hartree-Fock calculations. The projectile excitation of ^{32}S was also observed and yielded a limit for the first excited 2^+ state of $-0.05 < Q < 0.25$ b. (auth)

17812 NEUTRON POLARIZATION IN (d,n) AND (^{3}He,n) STRIPPING REACTIONS ON LOW-A NUCLEI. Thomason, Richard Sumner. Durham, N. C.; Duke Univ. (1969). 186p. University Microfilms Order No. 70-18,101.

Thesis.

Angular distributions of the neutron polarizations were measured for the n_0 and n_1 groups from the ^{6}Li(d,n) and ^{7}Li(d,n) reactions for deuteron energies from 2.5 to 3.8 MeV; for the n_0, n_1, and unresolved ($n_2 + n_3$) groups from the ^{9}Be(^{3}He,n) reaction for ^{3}He energies from 2.1 to 3.9 MeV; and for the n_0 groups from the ^{11}B(^{3}He,n) and the ^{13}C(^{3}He,n) reactions from 3.0 to 3.8 MeV. Targets were used that were generally about 200 keV in thickness to the incident ions. Helium was used as a polarization analyzer. The polarization distributions for the four groups from the (d,n) reactions have shapes that are very constant with energy. The maximum absolute value of the measured polarizations is greater than about 0.40 for all these reactions except ^{7}Li(d,n_1). Distorted-wave Born-approximation calculations, in which capture of the proton in the 1p shell with $j = 3/2$ was assumed, were made for the ^{6}Li(d,n_1) and ^{7}Li(d,n_0) reactions at 3.7 MeV. Reasonable agreement with cross section data was obtained; the predicted polarizations resembled the measured data. The shapes of the distributions for the measured groups from the ^{9}Be(^{3}He,n) reactions show a small, gradual change with energy; and the absolute value of the measured polarizations is less than about 0.40 for all three groups. The polarization distributions for the ^{11}B(^{3}He,n_0) group have shapes that are constant with energy within the experimental uncertainties; the polarization averaged over the energy range measured has a minimum of about −0.12 and a maximum of about +0.24. The shapes of the distributions for the ^{13}C(^{3}He,n_0) reaction between 3 and 4 MeV have moderate fluctuations about the average shape; the magnitude ranges from −0.64 to +0.34 over this range. Distorted-wave Born-approximation calculations, in which transfer of the diproton with $S = 0$ was assumed, were made for the ^{9}Be(^{3}He,n_0), ^{11}B(^{3}He,n_0), and ^{13}C(^{3}He,n_0) reactions at the highest energy at which each was measured. Fits to ^{3}He-^{9}Be elastic-scattering data were made to obtain some of the optical-model parameter sets used. Reasonable agreement with cross section data was obtained in all cases except for ^{11}B(^{3}He,n_0); the predicted polarizations for ^{13}C(^{3}He,n_0) resembled the measured data, but the results for ^{9}Be(^{3}He,n_0) were less encouraging. (TSS) (Diss. Abstr. Int., B)

17813 INELASTIC NEUTRON SCATTERING FROM Fe, Al, AND Mn. Lamb, Richard C. Lexington, Ky.; Univ. of Kentucky (1963).

Thesis.

Cross sections were measured for inelastic neutron scattering to individual levels in ^{56}Fe, ^{27}Al, and ^{55}Mn. The Fe and Al measurements were done at 2.97 MeV; the Mn measurement at 2.21 MeV. The cross sections were determined from measurements

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of the de-excitation gamma rays. A pulsed neutron source permitted the use of timing circuitry to discriminate against all radiations other than sample gamma rays. The measurements were normalized to the 0.845-MeV gamma-ray cross section in ^{56}Fe; the value of this cross section is 1220 ± 50 mb at 2.97 MeV. Cross sections were measured for the 2.085- and the 2.66-MeV levels in ^{56}Fe; the 0.842-, 1.01-, 2.21-, and 2.73-MeV levels in ^{27}Al; and the 0.126-, 0.983-, 1.289-, 1.527-, and 1.884-MeV levels in ^{55}Mn. The total inelastic neutron cross section for ^{27}Al was measured to be 0.45 ± 0.04 b; for ^{55}Mn the total inelastic cross section was 1.29 ± 0.1 b. The cross sections to the individual levels were compared with Hauser–Feshbach-type calculations. Neutron penetrabilities were adjusted so that calculated cross sections reproduced measured nonelastic and differential elastic cross sections. The measured and calculated inelastic cross sections are in good agreement for all levels with the exception of the 2.21-MeV level in ^{27}Al. The comparisons are used to infer the following spin sequence for the levels of ^{55}Mn: $\frac{7}{2}^-$ (0.126 MeV); $\frac{9}{2}^-$ (0.983 MeV); $\frac{11}{2}^-$ (1.289 MeV); and, tentatively, $\frac{5}{2}^-$ for the 1.527-MeV level. (TSS) (Diss. Abstr. Int., B)

17814 CROSS SECTIONS OF (n,n′γ) REACTIONS IN CHLORINE AND POTASSIUM. Nichols, Davis Betz. Lexington, Ky.; Univ. of Kentucky (1966).

Thesis.

Production cross sections for the ^{35,37}Cl(n,n′γ) reactions were measured at incident neutron energies of 2.54, 3.09, and 4.03 MeV. Angular distributions of the gamma rays were measured at 3.05 and 4.23 MeV. Gamma rays were detected with NaI(Tl) and Ge (Li) detectors using pulsed beam techniques to eliminate backgrounds. Interpretation of the angular distributions and production cross sections permitted spin assignments of $\frac{1}{2}$, $\frac{5}{2}$, and $\frac{7}{2}$ to the first three excited levels of ^{35}Cl, and $\frac{1}{2}$ and $\frac{5}{2}$ to the first and fourth excited levels of ^{37}Cl. Excitation energies of 1.726 ± 0.004 MeV and 3.71 ± 0.02 MeV were measured for these two levels of ^{37}Cl. Production cross sections for the ^{39,41}K(n,n′γ) reactions were measured at incident neutron energies of 1.82, 2.63, 3.42, and 3.96 MeV. The levels of ^{39}K studied are at 2.519, 2.817, 3.021, and 3.603 MeV excitation energy. Spin assignments and limitations are $\frac{1}{2}^+$ or $\frac{3}{2}^+$, $\frac{1}{2}^-$, $\frac{1}{2}^-$ or $\frac{3}{2}^-$, and $\frac{3}{2}^-$, respectively. Levels of ^{41}K studied are at 0.978, 1.291, 1.559, 1.581, and 1.675 MeV. The assignments and limitations are $\frac{1}{2}$ or $\frac{3}{2}$, $\frac{1}{2}^-$, ≤ $\frac{5}{2}$, $\frac{9}{2}$, ≤$\frac{5}{2}$. (Diss. Abstr. Int. B)

17815 (n,n′γ) REACTIONS AS A TOOL FOR NUCLEAR SPECTROSCOPY NEAR A = 70 AND AT A = 27. Chung, Kuoching. Lexington, Ky.; Univ. of Kentucky (1969). 64p. University Microfilms Order No. 70-16,965.

Thesis.

(n,n′γ) experiments were performed on four even-A Ge isotopes and on ^{27}Al by pulsed-beam time-of-flight techniques with a Ge (Li) detector. The 90° excitation functions of the γ-ray transitions in the Ge(n,n′γ) reactions were measured at incident neutron energies from 0.5 to 2.55 MeV. Angular distributions at E_n = 1.75, 2.13, and 2.55 MeV were also measured. The γ-ray production cross sections and the neutron inelastic-scattering cross sections were obtained at these neutron energies. Theoretical calculations are performed and are in good agreement with the experimental results. The Wolfenstein–Hauser–Feshbach formalism is used for the calculations. Branching ratios and mixing ratios of the γ-ray decay from the second 2^+ state for all the four even-A isotopes were obtained. The 1698-keV level of ^{74}Ge was confirmed, and its decay to the first and second 2^+ states was established. It emits 1102- and 493-keV γ rays. A branching ratio and mixing ratios are determined. A spin of 3 is tentatively assigned to that level for the first time in this work. From these measurements and other available information, the excited energy levels identified below 2.2 MeV are 1041 (2^+) 1216 (0^+), 1709 (2^+), 2153 (4^+), 2157 (2^+), in ^{70}Ge; 691 (0^+), 834 (2^+), 1465 (2^+), 1730 (4^+), 2065 (3^+), in ^{72}Ge; 596 (2^+), 1205 (2^+), 1464 (4^+), 1484 (0^+), 1698 (3), 2198 (2^+), in ^{74}Ge; and 563 (2^+), 1109 (2^+), in ^{76}Ge. The energies are in keV. In addition, a test of the necessity for fluctuation corrections to the statistical model at mass region near A = 70 was made. Tests with neighboring odd- and even-A nuclei show no need for such corrections. Applying the corrections worsens the agreement between theory and experiment. The ^{27}Al (n,n′γ) reactions were measured at E_n = 3.5 MeV. The excitation energies of observed levels are 843-, 1013-, 2213-, 2730-, 2980-, and 3002-keV. Angular distributions of transitions and neutron inelastic-scattering cross sections to all observed levels were obtained except those to the 843-keV level. The cross sections are well reproduced by the model calculations. The 2980- and 3002-keV levels were studied separately in this experiment, and the results support the $\frac{9}{2}$ assignment to the 3002-keV level. (Diss. Abstr. Int., B)

17816 NEUTRON CROSS SECTIONS OF CALCIUM AND POTASSIUM FROM 2.0 TO 8.0 MeV. Reber, Jerry Donald. Lexington, Ky.; Univ. of Kentucky (1967).

Thesis.

The differential cross sections for elastic scattering of neutrons were measured for calcium at neutron energies of 2.06, 3.29, 5.30, 5.88, 6.52, and 7.91 MeV and for potassium at neutron energies of 2.06, 3.74, 4.33, 6.52, and 7.91 MeV. The measurements were made using time-of-flight techniques and a liquid scintillator equipped with gamma-ray discrimination. The calcium and potassium scattering samples were solid right circular cylinders about 2.5 cm in diameter by 4 cm long. Each angular distribution was normalized by comparison with n–p scattering at 40° using a polyethylene sample. The angular distributions were corrected for multiple scattering and flux attenuation in the sample, angular resolution, and dead time of the counting electronics. Transmission measurements of the total cross section for both nuclei were made between 1.8 and 8.3 MeV. The experimental data are compared to optical model calculations using the computer code ABACUS-2. The optical model potential consists of a Wood–Saxon real part, derivative Wood–Saxon imaginary part, and a Thomas-type spin–orbit part. The compound-elastic contributions to the elastic differential cross sections are included using the Hauser–Feshbach formalism. By varying the three potential strengths, good fits are obtained at each energy. The variation of the parameters as a function of energy is discussed. (Diss. Abstr. Int., B)

17817 3.95-MeV LEVEL AND DECAY SCHEME OF ISOBARIC-ANALOG 8.38-MeV STATE IN ^{35}Cl NUCLEUS. Migalenya, V. Ya.; Kopanets, E. G.; Lvov, A. N.; (and others) (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh.; 15: 1200-2(Jul 1970). (In Russian).

A spectrum of γ rays formed during the decay of the 8.38-MeV level in ^{35}Cl was studied by means of a spectrometer with Ge(Li) detector. Tabulated data are given for the observed γ spectrum which indicate the assumed transitions between levels in ^{35}Cl nuclei and the relative intensity of these transitions. The decay scheme of the 8.38-MeV level is given with a new level in ^{35}Cl with the excitation energy of 3.947 ± 0.014 MeV included. (R.V.J.)

17818 NUCLEAR REACTIONS OF ^{12}C, ^{20}Ne, AND ^{40}Ar INDUCED BY 14-MeV NEUTRONS. Kardonsky, Stanley. New York; City Univ. of New York (1970). 72p. University Microfilms Order No. 70-19,550.

Thesis.

A gridded ionization chamber was used to study neutron-induced reactions in situ of ^{12}C, ^{20}Ne, and ^{40}Ar. Cross sections were calculated for these reactions to various energy levels in the product nuclei, with the ^{12}C(n,α_0)^{9}Be reaction as a neutron flux standard. The cross section for the ^{12}C(n,α_0) reaction was found to be 75 ± 40 mb. The ^{40}Ar(n,α) reaction total cross section was 9.4 ± 1.0 mb. Cross sections of the ^{20}Ne(n,p_0) and ^{20}Ne(n,2α) reactions were measured; these values were 1 mb and 38.0 ± 7.6 mb, respectively. The total cross section of the ^{20}Ne(n,α) reaction was measured to be 11.8 mb. Energy levels in product nucleus ^{37}S at 0.59 ± 0.10 MeV, 1.39 ± 0.09 MeV, 2.20 ± 0.05 MeV, 2.83 ± 0.09 MeV, and 3.50 ± 0.20 MeV were observed and found to be in excellent agreement with previously reported values. Ten levels in product nucleus ^{17}O were observed and found in agreement with prior work. Experimental cross sections for ^{40}Ar and ^{20}Ne were compared with theoretical and semiempirical predictions. The data indicated that all the above reactions proceed via direct mechanisms. A hypothesis as to the mechanism of the ^{20}Ne(n,2α) reaction suggests the reaction proceeds via two competing mechanisms. (Diss. Abstr. Int., B)

17819 PARTICLE AND COLLECTIVE NATURE OF THE STATES IN ^{86}Sr. Friedman, Melvin H. Pittsburgh; Carnegie-Mellon Univ. (1969). 223p. University Microfilms Order No. 70-17,140.

Thesis.

The collective and particle nature of the ^{86}Sr states were studied by the ^{86}Sr(α,α′) and ^{87}Sr(d,t) reactions. Inelastic alpha differential-cross-section angular distributions were obtained for five of the excited states of ^{86}Sr. From these measurements deformation-parameter and parity determinations are made. Fractionization of the octupole states was observed, and comparison is made with Veje's theory. The systematic behavior of the principal octupole state is extended to include the ^{88}Sr nucleus. ^{87}Sr(d,t) cross-section angular distributions were obtained for thirteen of the states in ^{86}Sr. From these measurements spectroscopic factors and parity determinations are made for the ^{86}Sr nucleus. The $g_{\frac{9}{2}}^{-2}$ and $g_{\frac{9}{2}}^{-1}-p_{\frac{1}{2}}^{-1}$ states predicted by Talmi and Unna are identified. Evidence is found which supports the assumption that the neutron two-hole interaction in ^{86}Sr is the same as the proton two-particle interaction in ^{90}Zr. The location of the neutron $1g_{\frac{9}{2}}$, $2p_{\frac{1}{2}}$, $2p_{\frac{3}{2}}$, and $1f_{\frac{5}{2}}$ single-particle energies was measured. Arguments are given which suggest tentative spin

assignments for the 2.675-, 2.86-, 3.03-, 3.189-, and 3.511-MeV states. The amount of $g_{\frac{9}{2}}^{-1}-x_j^{-1}$ configuration present is measured for a number of states in ^{86}Sr. (Diss. Abstr. Int., B)

17820 STUDY OF (p,n) REACTIONS IN ^{51}V AND ^{68}Zn. Egan, James Joseph. Lexington, Ky.; Univ. of Kentucky (1969). 154p. University Microfilms Order No. 70-16,970.

Thesis.

Two pairs of isobaric-analog resonances near 4.1 and 4.9 MeV proton bombarding energy were studied in the ^{68}Zn(p,n)^{68}Ga reaction. Differential cross sections were measured at 2.5, 30, and 130° for neutrons which leave ^{68}Ga in the ground state and 180-keV first excited state in the bombarding energy region from 4.00 to 4.15 MeV. Analog resonances at 4.075 and 4.098 MeV were analyzed according to the Robson theory. Eleven levels in ^{68}Ga up to an excitation energy of 1.088 MeV were identified in time-of-flight spectra. Hauser–Feshbach analyses were done on the angular distributions of neutrons leaving ^{68}Ga in 4 and 6 residual nucleus states at 4.400 and 4.512 MeV respectively, an energy region where no analog resonances appear. Excitation functions for seven neutron groups were measured at 100° in the bombarding energy region 4.7 to 5.0 MeV where two analog resonances, at 4.87 and 4.92 MeV, were seen. An analysis according to the theory of Robson was performed on these resonances in order to obtain spins, parities, and resonance parameters. The 2.335-MeV isobaric analog resonance in ^{51}V(p,n)^{51}Cr and ^{51}V(p,p)^{51}V was analyzed according to the Robson theory. A negative resonance mixing phase was required to fit the resonance in the proton elastic scattering data. This corresponds to a positive level shift when fitting the resonance in the (p,n) data. ^{51}V(p,n)^{51}Cr angular distributions at 4.013 and 5.016 MeV bombarding energies were analyzed via the Hauser–Feshbach formalism. Twelve states in ^{51}Cr were observed up to an excitation energy of 2.39 MeV, including a level at 2.27 MeV which is suggested to be a high-spin state. (Diss. Abstr. Int., B)

17821 PROPERTIES OF ^{29}P, ^{33}S, AND ^{33}Cl NUCLEI FROM DOPPLER-SHIFT ATTENUATION AND ANGULAR CORRELATION MEASUREMENTS. Cummings, John Ernest. Tucson, Ariz.; Univ. of Arizona (1970). 116p. University Microfilms Order No. 70-17,783.

Thesis.

The particle–gamma-coincidence version of the Doppler-shift attenuation method was employed to obtain the following information on the mean lives of low-lying states: in ^{29}P — τ(1.38 MeV) = $(2.1 \pm 0.6) \times 10^{-13}$ sec, τ(1.95 MeV) = $(3.2^{+1.0}_{-1.5}) \times 10^{-13}$ sec; in ^{33}S — τ(0.84 MeV) = $(9^{+2}_{-3}) \times 10^{-13}$ sec, τ(1.97 MeV) = $(1.5 \pm 0.3) \times 10^{-13}$ sec, τ(2.31 MeV) = $(1.4 \pm 0.4) \times 10^{-13}$ sec, τ(2.94 MeV) > 1.4×10^{-12} sec, τ(3.22 MeV) = $(4^{+2}_{-1}) \times 10^{-14}$ sec; and in ^{33}Cl — τ(0.81 MeV) > 1.3×10^{-12} sec. In addition, the particle–gamma-ray method for angular correlation measurements was used to obtain multipole-mixing ratios of $x = +(0.36^{+0.06}_{-0.05}; {}^{+0.7}_{-0.3})$ for the 1.97- → 0.0-MeV transition, and $x = +(0.11^{+0.05}_{-0.08}; {}^{+0.11}_{-0.09})$ or $x = +(1.34 \pm 0.26)$ for the 2.31- → 0.84-MeV transition in ^{33}S. The reduced matrix elements for the electromagnetic transitions among some of the low-lying states in ^{29}P and ^{33}S were obtained. These reduced matrix elements were compared, where applicable, with the predictions of the extreme single-particle model, the shell model with configuration mixing, and the Nilsson rotational model. On the basis of the rotational-model analysis, values of the deformation parameter, $\delta = \Delta R/R_0$ (where ΔR is the difference between the major and minor axes of a spheroidal nucleus, and R_0 is its mean radius), were obtained as follows: $|\delta|_{^{29}P} \simeq 0.40 \pm 0.10$; $|\delta|_{^{33}S} \simeq 0.12^{+0.06}_{-0.04}$. A value of 1949 ± 2 keV was obtained for the excitation energy of the second excited state in ^{29}P. (TSS) (Diss. Abstr. Int., B.)

17822 (^{3}He,d) STRIPPING REACTION ON MEDIUM-WEIGHT NUCLEI. Cage, Marvin Eugene. Boulder, Colo.; Univ. of Colorado (1969). 119p. University Microfilms Order No. 70-16,470.

Thesis.

The ^{39}K(^{3}He, ^{3}He)^{39}K and ^{113}In(^{3}He, ^{3}He)^{113}In elastic-scattering experiments were performed to obtain ^{3}He optical-model parameter sets necessary for the DWBA analyses. Two sets of parameters were found for each reaction: the families with the deeper real well depths yielded the better results for both (^{3}He,d) experiments. The ^{39}K(^{3}He,d)^{40}Ca reaction, performed with a 29.3-MeV ^{3}He beam, provided information on the ground state of ^{40}Ca and 17 excited states, including 2 new states; an overall resolution of 100 keV FWHM was achieved with a E–dE/dx detector telescope and particle-identification system. Angular distributions, partial strengths, and spectroscopic factors were extracted for 14 of these states. Proton particle–hole states having $(1d_{\frac{3}{2}}^{-1}\ 1T_{\frac{1}{2}})^{J=2,3,4,5}_{T=0,1}$ and $(1d_{\frac{3}{2}}^{-1}\ 2p_{\frac{1}{2}})^{J=0,1,2,3}_{T=0}$ configurations were observed. A 37.7-MeV incident ^{3}He beam was used for the ^{113}In(^{3}He, d)^{114}Sn reaction. The ground state of ^{114}Sn and 15 excited states were observed, including 12 new states, with an overall resolution of 150 keV FWHM. Partial strengths were extracted from the angular distributions of 8 peaks, plus 2 sets of peaks containing closely spaced triplets of levels. Angular momentum transfers corresponding to l = 2, l = 4, and l = 5 were observed; these are believed to result from the transferred proton's occupying $2d_{\frac{5}{2}}$, $1g_{\frac{9}{2}}$, and $1h_{\frac{11}{2}}$ orbitals, respectively, and being coupled to a hole in a $1g_{\frac{9}{2}}$ orbital. (TSS) (Diss. Abstr. Int., B)

17823 STUDY OF THE (^{3}He,t) REACTION AND ISOBARIC ANALOG STATES IN 1f–2p SHELL NUCLEI. Becchetti, Frederick Daniel Jr. Minneapolis; Univ. of Minnesota (1969). 84p. University Microfilms Order No. 70-15,700. Thesis.

The (^{3}He,t) reaction leading to isobaric-analog (IAS) and other states in the Ti, Fe, Ni, and Zn isotopes is studied at an incident ^{3}He energy of 24.6 MeV using a magnetic spectrometer and position-sensitive detectors. The (^{3}He,t)Q values measured are used to extract Coulomb displacement energies accurate to ±6 keV or less. The $0^+ \rightarrow 0^+$ analog strength in several nuclei with T > 1 appears to be shared by several states. Two cases in particular, ^{56}Fe–^{56}Co and ^{58}Fe–^{58}Co are studied further using (d,α) and other reactions. The results suggest large isospin mixing for these nuclei. Angular distributions for the $0^+ \rightarrow 0^+$ IAS transition are given for ^{46}Ti, ^{58}Ni, and ^{60}Ni as well as the $0^+ \rightarrow 2^+$ IAS* transition for ^{58}Ni and ^{60}Ni. Several non-analog states are also included. The Coulomb displacement energies and differential cross sections are analyzed using current macro- and microscopic models, and information about the nuclear neutron excess and the (^{3}He,t) reaction mechanism is obtained. Also presented is a global optical-model analysis of published ^{3}He and triton elastic scattering in the region with 40 < A < 210, 10 < E < 40 MeV. (Diss. Abstr. Int., B)

17824 STUDIES OF THE DECAY OF THE COMPOUND NUCLEUS ^{68}Ge. Barkan, S. (Simon Fraser Univ., Burnaby, B. C.); D'Auria, J. M.; Pate, Brian D.; (and others). pp 20-31 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The decay of the compound nucleus ^{68}Ge, formed via the reactions ^{4}He + ^{64}Zn, ^{12}C + ^{56}Fe, and ^{16}O + ^{52}Cr, was studied through measurements on product activation cross-sections, recoil nucleus ranges, and gamma-ray emission (the latter via in-beam experiments). The experimental results for cross-sections are compared with those from compound statistical calculations featuring explicit inclusion of angular momentum effects. Good agreement is observed when literature values of binding energy and other parameters are employed. Data on the emission of gamma-rays are expected to test the predictions of the calculations in considerably more detail, particularly as to the distribution in energy and angular momentum of the nuclei produced as a result of particle evaporation. The preliminary results presented are interpreted in a qualitative way as to the origin of the spectrum characteristics discussed. (auth) (UK)

17825 ASYMMETRY OF THE INELASTIC SCATTERING OF 20.3 MeV POLARIZED PROTONS ON ^{24}Mg, ^{26}Mg, AND ^{28}Si. Lombard, R. M.; Mayer, B.; Raynal, J. (CEA, Saclay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.90-1(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

A coupled channel analysis introducing a deformed L.S. coupling was performed for ^{24}Mg, ^{26}Mg and ^{28}Si. The introduction of the full Thomas term with an angular dependence for the spin-orbit potential improves the fit to the asymmetry data. (auth) (France)

17826 MEASUREMENT OF THE DEPOLARIZATION PARAMETER IN PROTON ELASTIC SCATTERING. Beurtey, R.; Catillon, P.; Schnabel, P. (CEA, Saclay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.96-7(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The measurement of the depolarization of a proton beam elastically scattered by ^{27}Al, ^{10}B and ^{9}Be is described. Experimental results indicate a small but measurable spin-flip cross section. (auth) (France)

17827 PRODUCTION OF FAST LIGHT FRAGMENTS IN THE INTERACTION OF 20 GeV PROTONS WITH ALUMINUM. Alard, J. P.; Bolta, J. M.; Cordaillat, A.; (and others) (Univ., Clermont-Ferrand, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.100-1(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

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The energy spectra of fast light fragments produced in 20 GeV proton interactions on aluminum are given for angles between 20 and 60°. (auth) (France)

17828 PICK-UP REACTIONS WITH CORE EXCITATION ON ^{28}Si AND ^{40}Ca. Romero, M.; Buenerd, M.; Dupont, Y.; Chabre, M.; Depommier, P. (Univ., Grenoble, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.119-20(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The ^{28}Si(p,d)^{27}Si and ^{40}Ca(p,d)^{39}Ca reactions were studied between 30 and 45 MeV to look for J forbidden transitions involving at 2^+ (in ^{28}Si) or 3^- (in ^{40}Ca) core excitation. A calculation of this process in the entrance channel accounts for 50% of the cross section observed for the transition to the $^7/_2^+$ state at 2.17 MeV in ^{27}Si. (auth) (France)

17829 STUDY OF ^{28}Si(^{3}He,α)^{27}Si AT LOW ENERGY. Rotbard, G.; Ronsin, G.; Kalifa, J.; Vergnes, M. (Univ. Paris, Orsay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.121-2(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Close to the Coulomb barrier the (^{3}He,α) reaction results from a competition between pickup and a less direct mechanism. Even when pickup dominated, the measurement of only one angular distribution did not permit extraction of a reliable spectroscopic factor. (auth)

17830 THEORETICAL STUDY OF ELASTIC AND INELASTIC SCATTERING CROSS SECTIONS OF FAST NEUTRONS OF SULFUR. Le Rigoleur, C.; Kinney, W. E.; Perey, F. G. (Oak Ridge National Lab., Tenn.). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.133-4(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Elastic and inelastic neutron cross sections on sulfur at 5.44, 6.37, 7.54, 8.52 MeV were calculated. The contribution of direct interaction to the neutron inelastic scattering to the 2^+(2.24) and 3^-(5.01) levels were added to the compound process. (auth) (France)

17831 STUDY OF (p,d) REACTIONS WITH A BEAM OF POLARIZED PROTONS. Escudie, J. L.; Gosset, J.; Kamitsubo, H.; Mayer, B. (CEA, Saclay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.135-6(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Differential cross sections and asymmetries were measured for (p,d) reactions on ^{49}Ti, ^{57}Fe, ^{91}Zr, ^{118}Sn and ^{119}Sn. These experiments, added to previous (p,d) experiments on ^{53}Cr, ^{61}Ni, ^{90}Zr, showed a strong j dependence of the measured asymmetries. The D.W.B.A. generally gave a good agreement for both cross sections and asymmetries. (auth) (France)

17832 PARITIES OF SOME EXCITED LEVELS OF ^{15}N FROM 9.05 TO 10.7 MeV. Chambon, B. (Univ., Lyon); Drain, D.; Vidal, J. L.; (and others). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.139-40(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The ^{15}N excited states between 9.05 and 10.07 MeV were studied from the ^{14}N(d,p)^{15}N reaction. The angular distributions for proton groups corresponding to 9.05, 9.16, 9.22 and 10.07 MeV levels in ^{15}N were measured at E_d = 3 MeV. l_n transfer-values and absolute spectroscopic factors of these transitions were deduced from D.W.B.A. analysis. (auth) (France)

17833 STUDY OF THE ^{48}Ti(t,α)^{47}Sc REACTION AT 12 MeV: PRELIMINARY RESULTS. Baudinet-Robinet, Y. (Univ., Liege); Delbrouck-Habaru, J. M.; Winand, L.; Vervier, J. J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.141(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The ^{48}Ti(t,α)^{47}Sc reaction was used at a bombarding energy of about 12 MeV to investigate the states of ^{47}Sc up to about 4 MeV excitation energy. The angular distributions for the first few levels were analyzed successfully by the DWBA method. (auth) (France)

17834 RADIATIVE CAPTURE OF FAST NEUTRONS IN Si, Rb, Sr, AND Y. Rigaud, F. (Univ. Bordeaux, Gradignan, France); Roturier, J.; Irigaray, J. L.; (and others). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.154-5(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Gamma-ray spectra from the radiative capture of 14.06 MeV neutrons in natural Si, Rb, Sr and Y were investigated by means of a time-of-flight spectrometer. The results were interpreted using direct and collective capture mechanisms including the contribution of the interference between them. The agreement between theory and experiment seems satisfactory. (auth) (France)

17835 MECHANISM OF ^{20}Ne(^{3}He,p)^{22}Na REACTIONS AT LOW ENERGIES (3 MeV). Meynadier, C.; Allard, J. F.; Beaumevieille, H.; (and others) (Institut d'Etudes Nucleaires, Algiers). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.162-3(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Angular distributions of the p_{0-4}, p_{8-12}, p_{14} groups were measured for the ^{20}Ne(^{3}He,p)^{22}Na reaction at $E_{^3He}$ = 2.8 and 3 MeV. Theoretical total cross sections calculated by the Hauser–Feshbach theory are in good agreement with averaged experimental ones except for p_{14}. (auth) (France)

17836 SPECTROSCOPY OF ^{62}Zn BY ^{64}Zn(p,t) REACTION. Bruandet, J. F.; Longequeue, N.; Longequeue, J. P.; Vignon, B. (Univ., Grenoble, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.168-9(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The lowest excited levels of ^{62}Zn were studied by ^{64}Zn(p,t) reaction at E_p = 40 MeV. Five levels were observed at Ex = 0.95, 1.75, 2.20, 2.65 and 3.10 MeV. The following values of J,π: 2^+ (0.95), 2^+ (1.75) and 3^- (3.10 MeV) are given. (auth) (France)

17837 REACTIONS INDUCED BY ^{7}Li ON ^{36}Ar. Tellez, A. (CEA, Saclay, France); Fouan, J. P.; Ballini, R.; Delaunay, J. J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.172-3(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The ^{7}Li induced reactions on ^{36}Ar were studied. The configurations excited preferentially in ^{40}Ca by ^{36}Ar(^{7}Li,t) appear to be more important in the higher states ($E_x \geq 10$ MeV). In the low lying ones, only even natural parity states are excited. For the rotational band built on the 3.35 MeV (0^+) level, the results are discussed together with those of (p,p'γ) reactions. (auth) (France)

17838 STATISTICAL NATURE OF ^{20}Ne(d,α)^{18}F AND ^{22}Ne(d,α)^{20}F REACTIONS UP TO 3.2 MeV. Morand, C.; Beaumevieille, H.; Dauchy, A.; (and others) (Institut d'Etudes Nucleaires, Algiers). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.205-6(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Excitation curves of the ^{20}Ne(d,$\alpha_{0-1-5-6}$)^{18}F reactions were plotted in the energy range 2 < E < 3.2 MeV. The α angular distributions of the ^{20}Ne(d,α)^{18}F and ^{22}Ne(d,α)^{20}F reactions were measured for the following states: 0, 0.93, 1.70, 2.10, 2.52 MeV of ^{18}F and 0, 0.65, 1.31 of ^{20}F. Theoretical total cross sections calculated by the Hauser–Feshbach theory, are in good agreement with the averaged experimental ones for the alpha groups with known characteristics. (auth) (France)

17839 SEARCH FOR AN INTERMEDIATE STRUCTURE IN THE TOTAL AND ELASTIC CROSS SECTIONS OF Ti. Adam, A.; Cabe, J.; Cance, M.; (and others) (CEA, Montrouge, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.217-18(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The total and elastic cross sections of neutrons on titanium between 150 and 1200 keV were measured. An intermediate state of $J = ^1/_2$ was found for 700 keV neutrons. (auth) (France)

17840 ENERGY LEVELS AND γ-RAY DECAY SCHEME OF ^{46}V. Chen, Siew-min. Tallahassee; Florida State Univ. (1970). 105p. University Microfilms Order No. 70-20,061.

Thesis.

The ^{46}V nucleus was reached by the ^{46}Ti(p,n)^{46}V reaction using two enriched metallic targets, ^{46}Ti and ^{48}Ti, 2 mg/cm^2 thick. An n-γ coincidence system was set up to overcome the complicated structure which otherwise appears in the γ-ray spectra. A coaxial Ge(Li) detector was used for γ-ray detection and a liquid scintillator for the neutron detection. Some n-γ coincidence spectra were obtained for the ^{46}Ti target at E_p = 8.8, 11.2, 11.5 and 12.0 MeV, and for the ^{48}Ti target at 11.5 MeV. To supplement these data, neutron spectra at 70 and 110° at E_p = 10.4 MeV were taken with ^{3}He proportional counters and an excitation function of the ^{46}Ti(p,n)^{46}V(β^+) reaction was obtained with a plastic scintilla-

tor to detect the ^{46}V β^+-activity as a function of proton energy from 7.9 to 12.0 MeV. The absolute cross section was measured at 9.7 MeV to be 20.4 mb. Four energy levels of ^{46}V excitation energy were fixed energetically with the γ-ray spectra taken at several proton energies as primary and the neutron spectra and the excitation function as supporting data. The accuracy of these levels (910, 1250, 1375 and 1675 keV) is better or equal to 7 keV. The γ-decay scheme was determined and the branching ratio calculated. Assuming that the low-lying levels of ^{46}V have positive parities, tentative spins for the 910, 1250, 1375 and 1675 keV levels were assigned to be (2^+), $(3^+$ or $4^+)$, $(1^+$ or $2^+)$ and (5^+), respectively, from the γ-decay scheme and the branching ratios. Some γ-rays from ^{48}V were also observed. Based on the known energy level scheme of ^{48}V, and on the assumption that γ-rays from low-lying levels will show up more strongly, several of the observed γ-rays were tentatively assigned to the decay of ^{46}V levels. (Diss. Abstr. Int., B)

17841 FINE STRUCTURE OF ANALOG STATES IN ^{61}Cu, ^{63}Cu, AND ^{65}Cu. Browne, John Charles. Durham, N. C.; Duke Univ. (1969). 129p. University Microfilms Order No. 70-20,259. Thesis.

Differential cross sections were measured at laboratory angles of 160, 135, 120 and 90° for $^{60}Ni(p,p)$, $^{62}Ni(p,p)$ and $^{64}Ni(p,p)$ at energies ranging between 1.8 and 3.3 MeV. The $^{64}Ni(p,n)$ total cross section was measured from threshold (~2.50 MeV) to 3.3 MeV. All data were taken using a high resolution electrostatic analyzer-homogenizer system in a 3 MV Van de Graaff laboratory. A total resolution of 300 to 400 eV was realized using thin solid targets of the enriched nickel isotopes. The analogs of the second, sixth and eighth excited states of ^{61}Ni were identified in the $^{60}Ni(p,p)$ experiment. The analogs of the ground state, second and third excited states of ^{63}Ni were observed in the $^{62}Ni(p,p)$ experiment. The analog of the first excited state of ^{65}Ni was identified in the $^{64}Ni(p,p)$ experiment. In all cases, the analog state was fragmented into individual fine-structure resonances. The resonance parameters were obtained by an R-matrix analysis. Only $l = 1$ analog states were observed. Spectroscopic factors were obtained using the resonance parameters extracted from the data and the calculated single-particle widths for these states. Single-particle widths were estimated by calculations using an optical-model code. The spectroscopic factors disagree in many cases with the spectroscopic factors for the parent states extracted from (d,p) measurements. The analog of the second excited state of ^{63}Ni was also observed by elastic proton scattering on a thick ^{62}Ni target. A comparison between these gross-structure results and the averaged fine-structure data was made. The spectroscopic factor for the thick target data is consistent with the spectroscopic factor obtained from the fine-structure measurements. Both numbers, however, disagree with the results of other gross-structure measurements (Gaarde et al., 1966). Coulomb energy differences were calculated for the seven $l = 1$ analog states and their parents. Very consistent results were obtained assuming a $Z/A^{\frac{1}{3}}$ variation for the Coulomb energy. (Diss. Abstr. Int., B)

17842 GAMMA-RAY YIELD CROSS-SECTION FOR INELASTIC SCATTERED FISSION NEUTRONS. Bakov, A. T.; Dvukhsherstnov, V. G.; Kazanskii, Yu. A. At. Energ. (USSR); 29: 338-42(Nov 1970). (In Russian).

The gamma spectra of inelastic scattered neutrons were measured on the neutron spectrum of the uranium to water reactor for Na, Al, Ti, V, Mn, Fe, Ni, Cu, Zn, Zr, Pb, Bi, and ^{238}U. The yield cross section and the number of separate gamma-quantum lines per one inelastic scattering, averaged for neutron energy range $En \geq E_{bound}$, were obtained (where E_{bound} is a boundary neutron energy when the production of gamma-rays of a chosen energy is possible). (auth)

17843 THE DECAYS OF $^{82a+82b}As$ AND ^{78}Ge. Van Klinken, J.; Taff, L. M.; Dijkstra, H. T.; (and others) (Univ., Groningen, Netherlands). Nucl. Phys.; A157: 385-403(1970).

The decays of two states of ^{82}As are reported: ^{82a}As with $T_{\frac{1}{2}} = 19 \pm 1.5$ s and ^{82b}As with $T_{\frac{1}{2}} = 13.0 \pm 0.6$ s. Information on the decay of ^{78}Ge with $T_{\frac{1}{2}} = 40 \pm 4$ s was also obtained. Spectra of single β and γ rays, $\gamma\gamma$ and $\beta\gamma$ coincidence measurements and fast chemical separations were used to identify and to study the decays of these activities, particularly of $^{82a+82b}As$. The two isomers of ^{82}As probably have spin and parity 1^+(a) and 5^-(b). From their decays levels are proposed in ^{82}Se at: 654.8(2^+), 1731.2(2^+), 1735.4(4^+), 2550.8(3^+), 2894.2(4^-), 3454(5^-), 4091, (4321), and (4565) keV. An unusually large hindrance factor of the allowed β decay from the 1^+ state of ^{82a}As was noted. The partial decay scheme of ^{78}Ge has levels in ^{78}As at 230.4 and 772.9 keV and possibly at 985.9 keV. (auth)

17844 INELASTIC SCATTERING OF 50 MeV PROTONS BY ^{54}Fe. Mani, G. S. (Manchester Univ., Eng.). Nucl. Phys.; A157: 471-80(1970).

Inelastic proton scattering from ^{54}Fe at 49.35 MeV was studied with protons from a linear accelerator. Angular distribution for eleven excited states up to an excitation of 5 MeV in ^{54}Fe were obtained. Spin and parity assignments were made using DWBA analysis with first-order collective form factors. (auth)

17845 A STUDY OF THE REACTION $^{46}Ti(p,\gamma)^{47}V$ AT THE 1.363 MeV RESONANCE. McCallum, G. J.; Pohl, K. P. (Inst. of Nuclear Sciences, Lower Hutt, N. Z.). Nucl. Phys.; A157: 552-60(1970).

The reaction $^{46}Ti(p,\gamma)^{47}V$ was studied at the 1.363 MeV resonance by means of a 30 cm^3 Ge(Li) detector. Gamma branching ratio and angular distribution measurements were made. From these measurements together with the results of previous stripping reaction studies the spins and parities of a number of levels are deduced. (auth)

17846 NUCLEAR REACTION STUDIES IN THE NICKEL ISOTOPES: THE $^{62}Ni(d,p)^{63}Ni$ AND $^{64}Ni(d,p)^{65}Ni$ REACTIONS. Anfinsen, T. R. (Univ. of Bergen); Bjoerndal, K.; Graue, A.; (and others). Nucl. Phys.; A157: 561-76(1970).

The reactions $^{62}Ni(d,p)^{63}Ni$ and $^{64}Ni(d,p)^{65}Ni$ were studied at a bombarding energy of 7.5 MeV. With an energy resolution of approximately 13 keV, 78 levels in 63 Ni and 57 levels in ^{65}Ni were observed below 5.2 and 4.7 MeV, respectively. The angular distributions of the proton groups were measured for the majority of the levels and analyzed in terms of zero-range distorted-wave Born approximation calculations. Thus, information about the orbital angular momentum of the transferred neutrons and the spectroscopic strengths of the stripping levels were obtained. A sum-rule analysis was made for the $2p_{\frac{1}{2}}$, $1f_{\frac{7}{2}}$, $2p_{\frac{3}{2}}$, and $1g_{\frac{9}{2}}$ single-particle states and the results compared with both shell-model predictions and recent pairing theory calculations. Levels whose angular distributions do not resemble any theoretical stripping curves are also discussed briefly, and some systematic trends in the level scheme of the odd Ni isotopes are mentioned. (auth)

17847 DECAY OF $^{73m,g}Se$, ^{75m}Ge, AND ^{77m}Ge. Meeker, R. D.; Tucker, A. B. (Ames Lab., Iowa). Nucl. Phys.; A157: 337-57 (1970).

The decays of $^{73m,g}Se$, ^{75m}Ge, and ^{77m}Ge were investigated. Energies and intensities were determined for 49 transitions in ^{73}As. A decay scheme for $^{73m,g}Se$ consisting of 20 excited states was constructed from the results of Ge(Li) singles and coincidence measurements. Ge(Li) singles measurements of γ rays accompanying the decay of the short-lived isomeric states in ^{75}Ge and ^{77}Ge were made. The energy of the isomeric transition in ^{75}Ge was determined to be 139.8 ± 0.1 keV. Log ft values for allowed β decay of this $\frac{1}{2}^+$ isomeric state to known low-lying $\frac{5}{2}^+$ and $\frac{3}{2}^+$ levels in ^{75}As were determined to be greater than 7.8 and 9.4, respectively. The energy of the isomeric transition in ^{77}Ge was determined to be 159.7 ± 0.1 keV. Direct β decay to levels at 195 and 614 keV was discovered. The low-energy level structure of $^{73,75,77}As$ is compared with recent theoretical predictions. (auth)

17848 AN IMPROVED SCHEME FOR THE DECAY OF 86 sec ^{61}Zn. Hoffman, E. J.; Sarantites, D. G. (Washington Univ., St. Louis). Nucl. Phys.; A157: 584-92(1970).

The levels in ^{61}Cu populated in the decay of 86 sec ^{61}Zn were reinvestigated using a 29 cm^3 Ge(Li) detector in an anti-Compton arrangement, which employed a large NaI(Tl) annular detector. From extensive γ energy and intensity measurements as a function of time ten new γ rays were assigned to ^{61}Zn decay and levels at 475.0, 970.3, 1311.0, 1394.6, 1660.5, 1904.5, 1932.5, 2088.8, 2204.3, 2358.2, 2472.6, 2684.0, 2793.0, 2840.6, 2857.0, 2933.3, 3019.2, 3092.3, and 3521.1 keV were observed to be populated in the decay of ^{61}Zn. From log ft values determined in this work, from γ intensity information, and from previously reported correlation data from nuclear reactions definite J^π assignments were made for six levels and limits were placed for another six levels in ^{61}Cu. (auth)

17849 GAMMA RAYS FROM THERMAL NEUTRON CAPTURE IN ^{28}Si, ^{29}Si, AND ^{30}Si. Beard, G. B.; Thomas, G. E. (Argonne National Lab., Ill.). Nucl. Phys.; A157: 520-8(1970).

Thermal-neutron capture γ rays from separated isotopes of silicon were investigated. The results for the $^{28}Si(n,\gamma)^{29}Si$ reaction agreed well with those from other recent investigations in which natural silicon or enriched ^{28}Si were used as targets. The use of targets enriched in ^{29}Si and ^{30}Si markedly increased the sensitivity for detection of γ rays from excited states of ^{30}Si and ^{31}Si. A total of 27 γ rays were seen in the $^{29}Si(n,\gamma)^{30}Si$ reaction, of which 16 are included in the level diagram. For the $^{30}Si(n,\gamma)^{31}Si$ reaction, all 13 observed transitions are included in the accompanying level diagram. The neutron binding energies for the silicon isotopes were found to be as follows: $B_n(^{29}Si) = 8474.2 \pm 0.5$ keV, $B_n(^{30}Si) = 10609.9 \pm 1.0$ keV, and $B_n(^{31}Si) = 6589.1 \pm 0.7$ keV. (auth)

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17850 THERMAL NEUTRON CAPTURE IN NATURAL ARGON. Hardell, R.; Beer, C. (Chalmers Tekniska Hogskola, Goteborg. Stockholm Univ.). Phys. Scr.; 1: 85-8(1970).

The energies and intensities of gamma rays from thermal neutron capture in natural argon have been determined by means of a Ge(Li) pair spectrometer and anti-Compton spectrometer. An internal reactor target has been used. The reaction Q-value, excitation energies and decay schemes of ^{37}Ar and ^{41}Ar have been deduced. (auth) (Sweden)

17851 DECAY OF BOUND ISOBARIC ANALOGUE STATES IN ^{28}Si AND ^{32}S USING (d,nγ) REACTIONS. Nilsson, L. (Aktiebolaget Atomenergi, Studsvik, Sweden); Nilsson, A.; Bergqvist, I. Phys. Scr.; 1: 161-8(1970).

A method has been developed for recording coincidences between neutrons and gamma-rays produced in (d,nγ) reactions. Neutron energies were measured by time-of-flight techniques, and a large NaI(Tl) crystal was used to determine gamma-ray energies and intensities. The neutron detector was placed in the forward direction to emphasize the excitation of $l_p = 0$ levels in the residual nuclei. The method was applied to the ^{27}Al(d,nγ)^{28}Si and ^{31}P(d,nγ)^{32}S reactions at the deuteron energy 4.0 MeV. The gamma-ray decay of a number of levels below 12 MeV in ^{28}Si and below 9 MeV in ^{32}S was studied. The isobaric analogue levels are prominently populated by the (d,n) reaction. The method is in particular suitable for studies of the decay of these levels. (auth) (Sweden)

17852 NUCLEAR LIFETIMES IN ^{37}K AND ^{39}K. Anttila, A.; Bister, M.; Arminen, E.; Kouki, T. (Helsinki Univ.). Phys. Scr.; 1: 169-71(1970).

The mean lives of levels in ^{37}K and ^{39}K have been measured with the Doppler-shift attenuation method through the ^{36}Ar(p,γ)^{37}K and ^{38}Ar(p,γ)^{39}K reactions. The ions ^{36}Ar (0.337%) and ^{38}Ar (0.063%) were separated and impregnated into a tantalum backing. The mean lives or their upper limits of the 2 523-keV, 3 020-keV and 7 738-keV states in ^{39}K and of the 2 750-keV state in ^{37}K were determined as $\tau_m = 32 \pm 12$ fs, 21 ± 6 fs, $.1 \pm 4$ fs, and $.1 \pm 6$ fs, respectively. The result obtained for the Q-value of the ^{38}Ar(p,γ)^{39}K reaction was 6 381.2 ± 1.2 keV. Some information concerning the decay of the ^{38}Ar(p,γ)^{39}K E_p = 1 393-keV resonance is also gained. The results on τ are compared with predictions from previous shell-model calculations. (auth) (Sweden)

17853 E_p = 1146 keV AND 1151 keV RESONANCES IN THE ^{31}P(p,γ)^{32}S REACTION. Holmberg, P.; Viitasalo, M. (Helsinki Univ.). Phys. Scr.; 1: 151-60(1970).

More evidence on the existence of resonances at E_p = 1146 keV and 1151 keV in the ^{31}P(p,γ)^{32}S reaction has been obtained. The decays of the resonances are investigated; and decay schemes, presented. Angular distributions of the strong transitions to the first excited state in ^{32}S are measured. Spin and parity 2^+ is suggested for both resonance states. (auth) (Sweden)

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Refer also to abstracts 15689, 15690, 15706, 15718, 15848, 15914, 17357, 17642, 17647, 17739, 17789, 17808, 17822, 17823, 17831, 17842, 18019, 18239, and 18242.

17854 (AD-712082) CHARGE DISTRIBUTION OF THE EVEN Nd ISOTOPES. Heisenberg, J. H.; McCarthy, H. S.; Sick, I.; Yearian, M. R. (Stanford Univ., Calif. High-Energy Physics Lab.). Jul 1970. Contract Nonr-225(67). 30p. (HEPL-615). NTIS.

High energy electron scattering was used to deduce the nuclear charge distribution of the ^{142,144,146,148,150}Nd. The measured cross sections were fitted using a two- and a three-parameter Fermi shape. A significant increase of the surface thickness between ^{142}Nd and ^{150}Nd is observed. The data for ^{142}Nd at high momentum transfer can only be fitted by introducing a modification on the charge distribution which is due to shell model effects. (auth) (USGRDR)

17855 (ANL-7678) FISSION-PRODUCT SPECTRA FROM FAST AND THERMAL FISSION OF ^{235}U AND ^{239}Pu. Varteressian K. A.; Burris, Leslie (Argonne National Lab., Ill.). Mar 1970. Contract W-31-109-eng-38. 469p. Dep. NTIS.

The yields of fission-product nuclides in irradiated uranium and plutonium, expressed as atoms per 100 atoms of ^{235}U or ^{239}Pu fissioned, were calculated, for both thermal and fast fission, as functions of irradiation time and cooling time. Fission-product yields are tabulated for irradiation and cooling times ranging from instantaneous to 10 years. Also included are tabulations of independent fission-fragment yields and of infinite-cooling-time stable fission-product yields. To make the numerous calculations possible, and to permit quick updating of data as new information on fission yields, half-lives, and decay schemes become available, computer codes known as DATAPREP and BURNUP have been developed. These, however, are by no means optimized at present and are included only as a matter of record. (auth)

17856 (CEA-CONF-1652) EFFECT OF SPIN-ORBIT TERMS OF THE OPTICAL POTENTIALS ON THE ASYMMETRY IN (p,d) EXPERIMENTS WITH POLARIZED PROTONS. Kamitsubo, H.; Mayer, B. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 2p. (CONF-700811-12). Dep. NTIS (U. S. Sales Only).

From 3rd International Symposium on Polarization Phenomena in Nuclear Reactions, Madison, Wis.

The effect of the spin-orbit terms in both proton and deuteron channels was studied in conjunction with the experimental results obtained for ^{118}Sn(p,d)^{117}Sn and ^{119}Sn(p,d)^{118}Sn reactions with polarized protons. The asymmetry in the ^{119}Sn(p,d)^{118}Sn reaction was shown to be very similar to that of protons elastically scattered by ^{119}Sn. D.W.B.A. calculations were in agreement with the (p,d) asymmetry when a spin-orbit term was included only in the proton channel (PSO). The contribution from the spin-orbit term in the deuteron channel did not radically change the asymmetry. The asymmetry given by a spin-orbit term in only the deuteron channel (DSO) was nearly in phase opposition with the PSO asymmetry, and the asymmetry calculated with spin-orbit terms in both channels was roughly equal to the sum of the asymmetries for PSO and DSO. D.W.B.A. calculations showed that the correlation between proton elastic scattering and (p,d) reaction disappeared at a lower energy. Opposite behavior in the asymmetry for PSO and DSO was seen in the partial-wave scattering amplitude, the spin-orbit force being more effective for lower partial waves. The effects of the spin-orbit term in the proton and deuteron channels were also shown for the case of $l_n = 2$ transfer. (France)

17857 (CEA-N-1339) SEARCH FOR A ^{238}Np FISSION ISOMER. Paya, Daniel; Katsanos, Anastasios; Leroy, Jean-Luc; Michaudon, Andre; Pranal, Yves (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov 1970. 9p. (In French). Dep. NTIS (U. S. Sales Only).

An attempt was made to investigate the possibility of forming a ^{238}Np fission isomer by bombarding a ^{237}Np target with 500-keV neutrons. The results indicated the existence of an isomer with a half-life of 12 ns. (auth) (France)

17858 (COO-1716-11) THERMODYNAMIC STUDIES ON HEAVY ELEMENTS AND STUDIES IN NUCLEAR CHEMISTRY. Annual Report, February 1970-January 1971. Cobble, J. W. (ed.) (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). 1 Jan 1971. Contract AT(11-1)-1716. 24p. Dep. NTIS.

Developments are given for studies on chemically bound neutrons and ternary fission of ^{232}Th and ^{197}Au with ^{4}He ions. In the case of ^{197}Au, success in measuring the formation cross section of a typical ternary product, ^{28}Mg, as low as 0.01 nanobarns (10^{-12} barns). The thermodynamic behavior of a typical actinide ion, UO_2^{++}, was determined over an extended range of temperature, 0 to 100°C from $C_{p_2}^0$ measurements. (P.C.H.)

17859 (COO-1746-53) MAGNETIC MOMENTS OF THE FIRST 2^+ STATES IN ^{192}Os AND ^{192}Pt. King, Wm. C.; Grabowski, Z. W.; Scharenberg, R. P. (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1970]. Contract AT(11-1)-1746. 10p. Dep. NTIS.

PAC measurements of the magnetic moments of the first 2^+ states in ^{192}Os and ^{192}Pt give 0.797 ± 0.036 and 0.90 ± 0.11 μ_N, respectively. Results agree with the 2(Z/A) values and differ appreciably from the Kumar and Baranger model predictions. Measurements using Fe(Ir) and Ni(Ir) alloys established the unsuitability of Fe(Ir) alloys for such experiments. NMR measurements of internal fields for ^{187}Os in Fe and Ni give H(296°K) = −1093.43 ± .65 kOe and H(295°K) = −282.3 ± 1.0 kOe, respectively. (auth)

17860 (CU-1019-76) ON THE ANGULAR DISTRIBUTION OF FISSION FRAGMENTS FROM THE ^{170}Yb COMPOUND NUCLEUS EXCITED TO 107 MeV. Kowalski, L.; Zebelman, A.; Kandil, A.; Miller, J. (Columbia Univ., New York. Dept. of Chemistry). Oct 1970. 7p. Dep. NTIS.

The angular distributions of the fission products formed in the reaction of 126-MeV ^{12}C ions with ^{158}Gd and 137-MeV ^{16}O ions with ^{154}Sm, both of which give ^{170}Yb compound nuclei at an excitation of 107 MeV, were measured. It is found that the angular distribution in the ^{12}C-ion entrance channel is proportional to $(1/\sin\theta)$ from about 25° to 155° in the center-of-mass system while the corresponding range is about 15° to 165° for the ^{16}O-

ion entrance channel. The total fission cross sections are 20 ± 2 mb and 39 ± 4mb for the two entrance channels, respectively. (auth)

17861 (IN-1448(Rev.)) GAMMA RAYS EMITTED BY THE FISSIONABLE NUCLIDES AND ASSOCIATED ISOTOPES. Cline, J. E. (Idaho Nuclear Corp., Idaho Falls). Dec 1970. Contract AT(10-1)-1230. 46p. Dep. NTIS.

Data on gamma-ray energies and intensities emitted by the nuclides present in nuclear fuel material are presented. These energies and intensities were measured using a high-resolution Ge(Li) spectrometer. Gamma-ray pulse-height spectra are given for reference use. (auth)

17862 (JAERI-1199) JAERI FAST REACTOR GROUP CONSTANTS SYSTEMS. PART II-1. Katsuragi, Satoru; Ishiguro, Yukio; Takano, Hideki; Nakagawa, Masayuki (Japan Atomic Energy Research Inst., Tokyo). Dec 1970. 120p. Dep. NTIS (U. S. Sales Only).

Improvements were made for the treatment of effective cross sections of heavy nuclides in the resonance energy region, and fast reactor group constants in this energy region were produced for nuclides ^{235}U, ^{238}U, ^{239}Pu, and ^{240}Pu. These group constants are thought to be accurate compared with existing fast group constants in the following sense: (1) The resonance parameters (including those in the unresolved resonance energy region) are evaluated so as to fit measured cross sections. (2) Accurate cross sections are obtained by a calculating procedure which uses a reasonable representation of cross sections without waste of computing time. (3) The effective cross sections are obtained using exact spectra as weights, because conventional approximation methods yield less accurate results. (4) An investigation was made for the treatment of interference effects. And interference effects with ^{238}U is taken into account for shielding factors. (5) The energy variation of $\alpha(\sigma_c/\sigma_f)$ values and σ_f for ^{235}U and ^{239}Pu is properly reproduced, and an appropriate group structure is adopted taking this energy variation into consideration. 100 references. (auth)

17863 (JINR-P6-5484) MEASUREMENT OF HALF-LIVES OF THE EXCITED STATES WITH THE ENERGY OF 155.8 AND 227 keV IN THE ^{155}Tb NUCLEUS. Vavryschuk, Ya.; Morozov, V. A.; Muminov, T. M.; Razov, V. I.; Sazhinskii, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

The half-lives of 155.8- and 227-keV excited levels of the ^{155}Tb nucleus were measured by the e − γ delayed coincidence method. Intrinsic quadrupole moment and the deformed parameter of the ground state of the ^{155}Tb nucleus were calculated. The hindrance factor is determined for the single-particle model, for the Nilsson model and for the Nilsson model with the superfluid correction for the transitions discharging the 227-keV state. (auth)

17864 (NP-18596) THE DECAY OF THE ^{127}Sn ISOMERS. Helander, Elisabeth (Helsinki Univ. (Finland). Dept. of Radiochemistry). Sep 1970. 48p. Dep. NTIS (U. S. Sales Only).

Gamma- and x-rays emitted in the decay of 2.2 h and 4.1 min ^{127}Sn were investigated with the aid of Ge(Li) and Si(Li) detectors. Sources were prepared by the ^{130}Te(n,α)^{127}Sn reaction followed by chemical separation. Altogether 62 γ-rays were attributed to the decay of 2.2 h ^{127}Sn and 3 to that of 4.1 min ^{127}Sn. Gamma-gamma coincidence and anticoincidence relationships in the decay of 2.2 h ^{127}Sn were observed with various Ge(Li)-Ge(Li) and Ge(Li)-Na(Tl) detector combinations. It is suggested that the 4.1 min $3/2^+$ isomer of ^{127}Sn represents the ground state and the 2.2 h $11/2^-$ isomer the first excited state in ^{127}Sn. A level scheme of ^{127}Sb was constructed, involving levels at 0, 491, 1096, 1114, 1585, 1920, 1938, 1955, 2004, 2094, 2098, 2124, 2140, 2150, 2222, 2247, 2275, 2318, 2353, 2360, 2412, 2457, 2479, 2501, 2531, 2588, 2612, 2692, 2697, 2764, 2785, 2806, 2847 and 2881 keV. The low-lying levels of the odd-mass antimony isotopes vary smoothly through the series ^{119}Sb to ^{127}Sb. Predictions of the pairing-plus-quadrupole and core-particle-coupling model are discussed. (auth)

17865 (NP-18598) LEVEL STRUCTURE OF ^{120}Sn FROM THE DECAY OF ^{120}In AND ^{120}Sb ISOMERS. Liukkonen, E.; Hattula, J. (Jyvaskyla Univ. (Finland). Dept. of Physics). Oct 1970. 31p. Dep. NTIS (U. S. Sales Only).

Gamma rays in the decay of the 3.2 s (1^+) and 44 s (4.5^+) ^{120}In isomers and the 15.9 min (1^+) and 5.8 d (8^-) ^{120}Sb isomers have been investigated using Ge(Li) spectrometers and prompt and delayed Ge(Li)-NaI(Tl) coincidence techniques. The constructed level scheme of ^{120}Sn contains 18 levels at the following energies (keV): 0 (0^+), 1171.6 (2^+), 1875.6 (0^+), 2096.9 (1,2,3), 2160.7 (0^+), 2195.0 (4^+), 2284.8 (5^-), 2355.6 (2^+), 2421.2 (1,2,3), 2466.3 (4^+), 2482.1 (7^-), 2643.5 (4^+), 3058.6 (4^+), 3179.7 (4^+), 3349.9 (3,4^+), 3440 (3,4^+), 3447.6 (5,6^+) and 3777 (4^+). The levels are compared with the levels obtained from recent charged-particle reaction studies and the structure of ^{120}Sn is briefly discussed in view of the latest quasiparticle calculations. (auth) (Finland)

17866 (NP-18599) ENERGY LEVELS OF ^{176}Yb FROM THE DECAY OF ^{176}Tm AND ^{176m}Yb. Tuurnala, T.; Pursiheimo, V.; Liukkonen, E. (Helsinki Univ. (Finland). Dept. of Physics). Feb 1970. 23p. Dep. NTIS (U. S. Sales Only).

The decay of ^{176}Tm has been studied by means of Ge(Li) detectors and some gamma-gamma as well as gamma-beta coincidence arrangements. For the half-life of ^{176}Tm a value of 1.9 ± 0.1 min was measured. A total of 31 gamma rays were assigned to the decay of ^{176}Tm. According to the proposed level scheme these depopulate 19 levels in ^{176}Yb, of which those at 977, 1360, 1599, 1673, 2142, 2372, 2411, 2954 and 3188 keV are new. Spin and parity assignments are suggested for some of these levels and for the ground state of ^{176}Tm. In addition, four gamma transitions possibly belonging to an isomer in ^{176}Tm were found with energies 116.3, 122.3, 193.6 and 199.0 keV and with half-life 1.4 ± 0.1 min. Also the decay of ^{176m}Yb has been reinvestigated the results obtained being consistent with the previous data. (auth) (Finland)

17867 $3^- \times 3^-$ TWO-PHONON QUARTET AND THE PROTON PAIRING VIBRATION IN ^{208}Pb. Blomqvist, J. (State Univ. of New York, Stony Brook). Contract AT(30-1)-4032. Phys. Lett.; 33B: 541-4(21 Dec 1970).

The observed large quadrupole moment of the collective 3^- state in ^{208}Pb is found to imply a considerable splitting of the two-octupole-phonon quartet. The 0^+ member of the quartet is predicted to come lowest in energy, possibly as far down as 3.7 MeV. Energy considerations strongly suggest that an observed 0^+ state at 5.26 MeV is the proton pairing vibrational state. (auth)

17868 COUPLING BETWEEN SPIN-FLIP AND NON-SPIN-FLIP PARTICLE-HOLE PAIR STATES. Fujita, J. I. (Tokyo Univ.); Hirata, M.; Shoda, K. Phys. Lett.; 33B: 550-2(21 Dec 1970).

Simple models are proposed in order to explain the recent experimental data on E1 radiative widths of isobaric analog states, which were obtained from (e,e'p) reactions through isobaric analog states. It is shown that these data strongly suggest the existence of coupling interactions between spin-flip and non-spin-flip neutron-hole-proton pair states. (auth)

17869 EVIDENCE OF THE POLAR EMISSION OF ALPHA-PARTICLES IN THE THERMAL NEUTRON FISSION OF ^{235}U. Piasecki, E.; Dakowski, M.; Krogulski, T.; Tys, J.; Chwaszczewska, J. (Inst. of Nuclear Research, Swierk, Poland). Phys. Lett.; 33B: 568-70(21 Dec 1970).

The energy-angular distribution of α-particles emitted during the thermal neutron fission of ^{235}U was measured. The surprisingly high rate of α-particles registered at angles close to 0 and 180° with respect to the fragment flight direction suggests the existence of polar emission phenomena. (auth)

17870 EFFECTIVE SPIN AND ORBITAL MAGNETISM OF THE PROTON STUDIED FROM THE g-FACTORS OF THE 8^+ STATES IN ^{90}Zr AND ^{92}Mo. Nagamiya, S. (Inst. of Physical and Chemical Research, Saitama, Japan); Katou, T.; Nomura, T.; Yamazaki, T. Phys. Lett.; 33B: 574-6(21 Dec 1970).

The g-factors of the $[\pi g_{9/2}^2]$ 8^+ states of ^{90}Zr and ^{92}Mo were determined to be 1.355 ± 0.018 and 1.409 ± 0.016, respectively, with the time-differential spin rotation method in $(\alpha,2n)$ reactions. Effective g_s- and g_l-factors of the proton in the A = 88 region are discussed. (auth)

17871 DECAY OF ^{129}Sb. Ohya, Susumu (Japan Atomic Energy Research Inst., Ibaraki); Tamura, Tsutomu; Kageyama, Seizaburo. J. Phys. Soc. Jap.; 29: 1435-45(Dec 1970).

The radiations emitted in the decay of ^{129}Sb were investigated with Ge(Li), Si(Li) and NaI detectors. From various coincidence studies on these transitions, it is concluded that excited levels are populated at 105.5, 180.8, 464.9, 544.7, 634.0, 760.1, 812.8, 966.6, 1228.3, 1281.3, 1317.5, 1599.0, 1633.0, 1654.6, 1727.0, 1736.5, 1752.6, 1842.8, 1870.3, 2070.1, 2085.3, 2113.0 and 2133.2 keV. The spin-parity values are tentatively assigned for low-lying levels. The results are compared with other odd-mass tellurium nuclei. (auth)

17872 ANGULAR AND ENERGY DISTRIBUTIONS OF α PARTICLES IN LRA FISSION. Vitta, Paul B. Atlanta; Emory Univ. (1970). 74p. University Microfilms Order No. 70-22,891. Thesis.

Detailed experimental studies were made on the angular and energy distributions of the long-range α particles (LRA) emitted

from ^{252}Cf during spontaneous fission. They show that the α-particle angular distribution is peaked at an angle (made by the trajectory of the α particle with that of either of the main fragments) of about 90° and has a full-width at half-maximum of 20°–30°. The α-particle energy spectrum is peaked at about 15 MeV and has a full-width at half-maximum of 13 MeV. Computer calculations of the trajectories of the three particles produced in LRA-fission lead to predictions of angular and energy distributions which may be compared with the experimental ones. The calculations were carried out using a set of initial conditions determined by the statistical theory of nuclear fission. The comparison with experimental results therefore provides a test of the statistical theory. The calculated results show that the statistical theory leads to an energy spectrum which is in good agreement with the experimental one, and that reasonable agreement between the calculated and experimental angular distributions may be obtained if it is assumed that the α particle is emitted within a short period of time — of the order of 3×10^{-22} sec — after the instant of scission. (Diss. Abstr. Int., B)

17873 POLARIZATION AND CROSS-SECTION MEASUREMENTS OF 9.7-MeV PROTON ELASTIC SCATTERING BY NUCLEI. Sievers, Jerry Albert. Minneapolis; Univ. of Minnesota (1970). 131p. University Microfilms Order No. 70-20,237. Thesis.

An investigation is made of the applicability of the standard optical model of nucleon-nucleus elastic scattering to the description and interpretation of proton elastic scattering at an incident energy of 9.7 MeV. Measurements of relatively high accuracy were made of the differential cross section and polarization in proton elastic scattering by ^{90}Zr, ^{120}Sn, and ^{181}Ta at scattering angles from 20 degrees to 155 degrees lab. The accuracy and completeness of these data provided a means for a more sensitive test of the model at this incident projectile energy than has been possible in the past. The applicability of a matter-parameterized optical model is also investigated. In this model, the real central and spin-orbit terms are derived from the nuclear nucleon density and the two-nucleon potential. It is found that the standard optical model produces the best agreement with the experimental polarization data only when the model spin-orbit interaction is allowed to occur at an unusually small radius, or when an imaginary part is added to the model spin-orbit term. The implications of this and of a similar result found with the matter-parameterized model are discussed. Other features of the model potentials determined by this analysis are similar to those determined in other work. The effects of variations in the detailed forms of the model potentials are thoroughly investigated, and features of the model potentials are correlated with certain physical properties of the nuclei. Predictions for the observables calculated with the effective scattering potentials of either the standard or the matter-parameterized model are in good agreement with the main features of the experimental data, and properties of the model potentials may be successfully correlated with the main physical effects in the scattering. Analysis of the present relatively accurate data indicates, therefore, that a potential description is an appropriate description of the main effects in elastic scattering at 9.7 MeV and that effects not treated explicitly in the first-order matter-parameterized model are small. (Diss. Abstr. Int., B)

17874 TRANSVERSE POLARIZATION OF THE K-CONVERSION ELECTRONS FOLLOWING THE BETA DECAY OF ^{203}Hg AS A FUNCTION OF THE BETA RAY ENERGY. Froechtenigt, Joseph Frank Jr. St. Louis; St. Louis Univ. (1969). 75p. University Microfilms Order No. 70-20,388. Thesis.

As a consequence of the non-conservation of parity in weak interactions, the conversion electrons following beta decay may have some degree of polarization transverse to their momentum and lying in the plane formed by the momentum vectors of the beta particle and the conversion electron. In this experiment, the transverse polarization of the K-conversion electrons of ^{203}Hg was measured as a function of the beta ray energy. The experiment consisted of detecting the beta particle and using a thin lens spectrometer to focus the conversion electrons onto a gold scattering foil. By means of Mott scattering through the foil, the measured left-right asymmetry in the scattered electron intensity was the basis for computing the parallel component of the transverse polarization, $P_{||}(\theta)$, as a function of the beta ray energy. The results show that the transverse polarization increases with energy, and within probable error, shows a linear dependence on v/c. Neglecting the perpendicular component of the transverse polarization, $P_{\perp}(\theta)$, the transverse polarization can be written as $P_{||}(\theta) = K\, v/c \sin\theta$ where K is the polarization constant. The polarization constant $K = +0.73 \pm .02$ also agrees with other results. (Diss. Abstr. Int., B)

17875 MONOPOLE MIXING RATIO OF THE 793 keV $2^+ \rightarrow 2^+$ TRANSITION IN ^{184}W. Doubt, H. A. (Univ. of Sussex, Eng.); Hamilton, W. D.; Davies, K. E.; Grabowski, Z. W. Nucl. Phys.; A156: 353-64(1970).

The amplitude mixing ratios of the E2 to M1 and E0 to E2 components of the 2^+(793 keV) 2^+ transition in ^{184}W were obtained from $\gamma\gamma$, and gamma-conversion electron angular correlation measurements. The $\gamma\gamma$ measurements used a Ge(Li) detector in some cases; the $e\gamma$ correlations were performed using a magnetic lens spectrometer. The results obtained are: $\delta(E2:M1) = +18.7^{+\infty}_{-5}$ and $+0.38 \geq q(E0:E2) \geq -0.28$ for $+53 \geq \lambda \geq -113$. Agreement with Kumar's theoretical values for δ and q is contradictory: the former favors a 2″ assignment, the latter a 2′ assignment to the 904 keV level. (auth)

17876 THE EXCITED STATES OF ^{129}Te POPULATED IN THE β-DECAY OF ^{129}Sb. Calway, P. G.; Sharma, H. D. (Univ. of Waterloo, Ont.). Nucl. Phys.; A156: 338-52(1970).

The energies and relative intensities of the γ rays following the decay of ^{129}Sb were measured using a Ge(Li) detector. The decay of 4.35 h ^{129}Sb was found to involve 85 γ rays and to populate 32 excited states in ^{129}Te. The energy level at 464 keV is considered to be a $^9/_2^-$ three quasi-particle "intruder" level similar to those found in ^{125}Te and ^{127}Te isotopes. Spin and parity assignments (of other levels) were made. (auth)

17877 THE β^- DECAY OF ^{112}Ag. Macdonald, John A.; Sharma, H. D. (Univ. of Waterloo, Ont.). Nucl. Phys.; A156: 321-37(1970).

The γ radiation following the decay of ^{112}Ag was studied with a Ge(Li) detector. A total of 118 γ rays was observed. Gamma–gamma coincidence measurements were performed with Ge(Li)–Ge(Li) and Ge(Li)–NaI(Tl) detectors. A decay scheme is proposed, which shows that 31 excited states of ^{112}Cd are populated following the β-decay of ^{112}Ag. Spin and parity assignments for the energy levels of ^{112}Cd are made. (auth)

17878 THE DECAY SCHEME OF 7 MIN ^{169}Lu. Charvet, A.; Duffait, R.; Emsallem, A.; Chery, R. (Univ., Lyon). Nucl. Phys.; A156: 276-88(1970).

The electron-capture decay ^{169}Lu(7 min) $\rightarrow$ ^{169}Yb was investigated with Ge(Li) and Si(Li) detectors. Single, coincidence, and sum γ spectra, conversion lines, and $e\gamma$ coincidence relations were studied. The results with respect to the ground state band, and the γ- and β-vibrational bands are in good agreement with those of earlier investigations. Above the γ-vibrational band, 16 levels were established having the following energies (in keV), spin values and parities: 1479.8(3,4); 1551.2, 3 or 4^+; 1597.8, 4^-; 1650.4, 3 or 4^-; 1674.1, 5 or 6^+; 1770.1, 5^-; 1819.4, 3 or 4^-; 1842.1, 5 or 6^-; 1972.8, 5 or 6^-; 1998.7, 5^-; 2110.5, (5) 6^-; 2135.4, (4); 2203.8, (3) 4^+; 2242.9, 4^+; 2404.6, (3) 4^+; 2427.8, 4^+. The decay scheme accounts for 76 of the 110 transitions observed. The Q-value of the electron-capture decay of ^{169}Lu(7 min) was determined to be 4360 ± 80 keV. The half-life of the 1998.7 keV level was found to be 12.4 ± 1.1 ns. The structure of ^{169}Lu(7 min) and of the levels of ^{169}Yb is discussed in terms of current nuclear models. (auth)

17879 DECAY OF ^{223}Ra AND ITS DAUGHTER PRODUCTS. II. THE DECAY OF ^{219}Rn AND ^{215}Po. Davidson, W. F.; Connor, R. D. (Univ. of Manitoba, Winnipeg). Nucl. Phys.; A149: 385-91(1970).

Gamma-rays of energy 130.7, 222.0, 271.2, 294.0, 401.8, 516.5, and 677 keV and absolute intensity (%) 0.104, 0.028, 9.93, 0.059, 6.48, 0.022 and ≈ 0.006 respectively have been observed in the decay of ^{219}Rn. Conversion electron studies show the 130.7 and 271.2 keV transitions to be M1 + 25% E2 and 93.6% E2 + 6.4% M1 respectively. The 401.8, 294 and 222 keV transitions appear to be E2, M2 and E2 respectively. The 6.551 MeV α-271.2 keV γ directional correlation gave $A_{22} = -0.108 \pm 0.073$ and $A_{44} = -0.170 \pm 0.056$. The sequence $^9/_2$-$^5/_2$-$^7/_2$ is proposed. (auth)

17880 EVIDENCE FOR A FOUR-QUASIPARTICLE STATE IN THE DEFORMED NUCLEUS ^{164}Dy. Kaffrell, N.; Herrmann, G. (Univ., Mainz). Phys. Lett.; 34B: 46-8(18 Jan 1971).

An allowed-unhindered β-ray transition was observed in the decay of 3.0 min ^{164}Tb to a level of ^{164}Dy at 2206 keV energy. This level is interpreted as a rather pure four-quasiparticle configuration. (auth)

17881 ALPHA DECAY OF ^{247}Cm. Fields, P. R.; Ahmad, I.; Friedman, A. M.; Lerner, J.; Metta, D. N. (Argonne National Lab., Ill.). Nucl. Phys.; A160: 460-70(1971).

An enriched sample of ^{247}Cm(99.4%) was used to investigate the α-decay scheme of ^{247}Cm. Seven α groups with energies and intensities 5.265(13.8%), 5.210(5.7%), 5.145(1.2%), 4.983(2.0%), 4.941(1.6%), 4.868(71.0%), and 4.818(4.7%) were observed. Gamma

singles and $\alpha-\gamma$ coincidence spectra showed the presence of 278.0-, 287.5-, 346.0-, and 402.4-keV γ rays. A two-parameter coincidence experiment established that the sources of the 402.4- and the 287.5-keV γ rays were 4.868- and 4.983-MeV α groups, respectively. The multipolarity of the 287.5-keV transition was found to be M1. The K-conversion coefficient of the 402.4-keV γ ray indicates an E1 multipolarity for this transition. The levels at 287.5 and 402.4 keV were assigned to the $5/2^+(622)$ and $9/2^-(734)$ Nilsson states, respectively. The half-life of ^{247}Cm was found to be $(1.56 \pm 0.05) \times 10^7$ yr from the α pulse analysis and mass spectrometric analysis of the sample. (auth)

17882 LOW-ENERGY NEUTRON ENERGY SPECTRA FROM (p,n) REACTIONS. Cohen, B. L.; Degnan, J. H.; Fink, C. L.; Rao, G. R.; Balasubramanian, R. (Univ. of Pittsburgh). Phys. Rev. Lett.; 26: 23-7(4 Jan 1971).

Coincidence experiments indicate that (p,np) reactions on ^{90}Zr and ^{112}Sn leave the residual nuclei in their ground states, whence neutron spectra can be deduced from measurements of proton spectra. Results are very different for the two nuclei. Analysis indicates that the variation of σ_i— the cross section for the inverse process— is larger than expected and in opposite directions for the two nuclei. (auth)

17883 IMPLANTATION OF TELLURIUM IN IRON AND MEASUREMENT OF THE MAGNETIC MOMENT OF THE FIRST EXCITED STATE IN ^{123}Te. Rots, M. (Univ. of Leuven, Belgium); Coussement, R.; Van Esch, R.; Boge, M.; Dousson, S. Z. Phys.; 240: 396-402(1970).

By means of an isotope separator ^{123m}Te was implanted into iron. The attenuation of the $e-\gamma$ angular correlation was measured using a randomly oriented magnetic hyperfine interaction. From this the magnetic moment of the 159-keV first excited $3/2^+$ state was found to be $|\mu| = 0.72 \pm 0.12$ n.m. This value is in agreement with the Kisslinger–Sorensen prediction and consistent with the systematics observed for the character of the $3/2^+-1/2^+$ transitions in the odd tellurium isotopes. (auth)

17884 NUCLEAR FISSION OF ACTINIUM NUCLEI AND THE TWO-MODE HYPOTHESIS. Perry, Dennis Gordon. Seattle; Univ. of Washington (1970). 110p. University Microfilms Order No. 70-19,648.

Thesis.

Nuclear fission induced in a target of ^{226}Ra by bombardment with energetic protons and deuterons is reported. Solid-state counters were used to measure kinetic energies of complementary fission fragments, and from these energies the fragment masses could be found. In the element region near radium triple-peaked mass-yield distributions are found— these represent a superposition of contributions from several nuclear species at different excitation energies. The triple-peaked mass distributions have sometimes been interpreted in terms of two separate fission modes: a single symmetric peak, characteristic of symmetric fission, associated with higher excitation energies, and a double-peaked distribution, characteristic of asymmetric fission, associated with lower excitation energies. It is shown that by a proper choice of proton and deuteron bombarding energies, and by a proper weighting of their respective mass-yield curves, the mass distribution of a single species ^{228}Ac can be determined for a single excitation energy. At excitation energies near 25 MeV this mass distribution for ^{228}Ac is shown to be single symmetric peak, in agreement with the hypothesis of two fission modes. It is shown further that the measured kinetic-energy distributions can also be interpreted in terms of the two-mode hypothesis. Although the fundamental reason for the existence of two fission modes remains obscure, these results considerably strengthen the case for two fission modes as a working hypothesis for analyzing mass and kinetic energy distributions. Experiments on the emission of α particles during fission of radium bombarded with protons are also reported. It is found that α particles are emitted in both fission modes with no evidence for one or the other fission modes being favored. (Diss. Abstr. Int. B.)

17885 PHENOMENOLOGICAL MODEL FOR THE SIMULTANEOUS ANALYSIS OF SEVERAL ROTATIONAL BANDS. Das, T. K.; Dreizler, R. M.; Klein, Abraham (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett.; 25: 1626-8(7 Dec 1970).

A theoretically based extension of the variable-moment-of-inertia model is proposed and applied to the simultaneous analysis of ground-state rotational and β-vibrational or γ-vibrational bands. The results are in excellent agreement with experiment. (auth)

17886 NON-STATISTICAL EFFECTS IN NEUTRON CAPTURE AT ^{98}Mo p-WAVE RESONANCES. Rohr, G.; Weigmann, H.; Winter, J. (EURATOM, Geel, Belg.). Nucl. Phys.; A150: 97-104(1970).

Neutron capture γ-ray spectra from individual ^{98}Mo + n resonances have been measured with a Ge(Li) detector. From the observation of very intense high-energy γ-rays it is concluded that several of the resonances are extraordinarily strong p-wave resonances with very large E1 strengths for decay into low-lying positive parity states in ^{99}Mo. Inspection of the ^{99}Mo γ-ray spectra themselves as well as a comparison with similar data for other nuclei in this mass region lead to results which are in contradiction to a statistical decay of the compound nucleus and suggest that nuclear structure effects like valency nucleon transitions play an important role in the decay of these resonances. Moreover, the extremely high value for the p-wave strength function computed from the ^{98}Mo + n resonances assigned as p-wave may be interpreted in terms of a strong energy dependence of the strength function due to the excitation of two-particle–one-hole doorway states. (auth)

17887 DETERMINATION OF THE E2/M1 MULTIPOLE MIXING RATIOS OF THE GAMMA TRANSITIONS IN ^{110}Cd. Krane, K. S.; Steffen, R. M. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 2: 724-34(Aug 1970).

The multipole character and E2/M1 mixing ratios of all γ transitions following the decay of ^{110m}Ag to ^{110}Cd were determined by measuring the 1–2, 1–3, and 1–4 directional correlations, using two 30–cc coaxial Ge(Li) detectors in conjunction with a multichannel coincidence gating system. The analysis of the data clearly demonstrated the necessity for careful investigations of the effects of the Compton background on directional correlation measurements using Ge(Li) detectors. The directional correlation functions for mixed $\gamma-\gamma$ cascades are given in terms of explicitly defined reduced matrix elements and their ratios $\delta(\gamma_n)$. The analysis of the 25 measured directional correlations yielded a consistent set of E2/M1 mixing ratios for all mixed multipole transitions. The E2/M1 amplitude ratios $\delta(\gamma_n) = \langle I_{n+1}||\hat{T}_N^{E2}||I_n\rangle / \langle I_{n+1}||\hat{T}_N^{M1}||I_n\rangle$ for the ^{110}Cd γ rays are (energies are in keV): $\delta(447) = -0.45 \pm 0.20$, $\delta(620) = -0.80 \pm 0.50$, $\delta(678) = -0.25 \pm 0.20$, $\delta(687) = -1.1^{+0.4}_{-0.3}$, $\delta(707) = -1.0 \pm 0.3$, $\delta(818) = -1.20 \pm 0.15$, $\delta(1384) = -0.37 \pm 0.03$, and $\delta(1505) = -0.55 \pm 0.10$. In terms of the multipole moments $\langle I_{n+1}||M(\pi L)||I_n\rangle$ of Bohr and Mottelson, the E2/M1 moment ratios $\Delta = \langle I_{n+1}||M(E2)||I_n\rangle / \langle I_{n+1}||M(M1)||I_n\rangle$ in natural units ($\hbar = m = c = 1$) are: $\Delta(447) = -3.0 \pm 1.3$, $\Delta(620) = -3.8 \pm 2.4$, $\Delta(678) = -1.09 \pm 0.88$, $\Delta(687) = -4.7^{+3.3}_{-1.4}$, $\Delta(707) = -4.2 \pm 1.3$, $\Delta(818) = -4.3 \pm 0.5$, $\Delta(1384) = -0.79 \pm 0.06$, and $\Delta(1505) = -1.08 \pm 0.20$. (auth)

17888 SEPARATION AND PAIRING ENERGIES INVOLVING ISOTOPES OF Tb, Dy, Ho, Er, Tm, Yb, Lu, AND Hf. Whineray, S.; Macdougall, J. D.; McLatchie, W.; Duckworth, Henry E. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A151: 377-400(1970).

Fifteen atomic mass difference determinations were combined with a large body of reaction and decay data in a recalculation of the separation and pairing energies for Hf and the heavier rare earth nuclei. The accuracy and reliability of the data are such that definite systematic trends are observed. The data have also allowed the accurate determination of three decay Q-values that were previously unknown. (auth)

17889 BETA-PARTICLE AND GAMMA-RAY ANGULAR DISTRIBUTIONS FROM ^{186}Re, ^{188}Re AND ^{194}Ir POLARIZED IN IRON AT LOW TEMPERATURES. Brewer, W. D.; Shirley, D. A. (Univ. of California, Berkeley). Nucl. Phys.; A149: 392-400 (1970).

Nuclei of ^{186}Re, ^{188}Re, and ^{194}Ir have been polarized in iron at low temperatures. The angular distributions of electrons from the first-forbidden β-decays were observed as functions of particle energy, using Li drifted germanium detectors. The anisotropies of the γ-rays which de-excite the 2^+ levels in the daughter nuclei were also measured. The information obtained is sufficient to permit an analysis for the nuclear matrix elements and possibly to use as a test of the conserved vector current hypothesis, but no detailed analysis has as yet been made. The β-particle angular distributions of the Re cases were in general agreement with previous results, but the experimental accuracy was greatly improved. (auth)

17890 NUCLEAR STRUCTURE STUDIES IN THE Te ISOTOPES: THE ^{125}Te(d,p)^{126}Te REACTION. Graue, A. (Univ. of Bergen); Lien, J. R.; Vinje, H.; Vold, P. B.; Moore, W. H. Nucl. Phys.; A160: 497-510(1971).

The reaction ^{125}Te(d,p)^{126}Te was studied at a bombarding energy of 7.5 MeV in order to get information about the ^{126}Te nuclear level scheme. Forty-two levels were observed below an excitation energy of 5.1 MeV. The angular distributions of 25 of the emitted proton groups were compared with DWBA calculations to determine the angular momentum of the captured neutrons. Contributions from more than one l_n value were observed for two of the transitions. Transition strengths were extracted and compared to pairing-theory calculations. (auth)

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17891 SOME REGULARITIES IN MULTINUCLEON TRANSFER REACTIONS WITH HEAVY IONS. Artukh, A. G.; Avdeichikov, V. V.; Eroe, J.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; A160: 511-16(1971).

Multinucleon transfer reactions were investigated by bombarding ^{232}Th and ^{197}Au targets with 137-MeV ^{16}O ions. An exponential yield dependence on the Q values was observed for nucleon exchange reactions. (auth)

17892 GAMMA RAYS FROM COULOMB EXCITATION OF ^{151}Eu AND ^{153}Eu. Lewis, T.; Graetzer, R. (Pennsylvania State Univ., University Park). Nucl. Phys.; A162: 145-60(1971).

De-excitation gamma rays following Coulomb excitation of ^{151}Eu and ^{153}Eu by 4.5 MeV protons and 5 to 11 MeV alpha particles were studied with a 2 cm^3 and a 50 cm^3 Ge(Li) detector. Excitation curves and reduced transition probabilities were measured. Nineteen gamma-ray transitions found in ^{151}Eu are interpreted as decay branches from levels of 195.8, 196.5, 243.0, 306.8, 500.0, 503.1, 578.0, 600.6, 719 and possibly 696, 781 and 906 keV. In ^{153}Eu ten gamma rays were found and are interpreted as decays from levels of 83.3, 151.3, 192.3, 569.0, 617.5 and 711.0 keV. The level energies are consistent with recent inelastic scattering data. In ^{153}Eu the level at 569.0 keV may be the gamma-vibrational band head with $J = \frac{9}{2}$. The levels at 617.5 and 711.0 keV may be the beta-vibrational band members with $J = \frac{5}{2}$ and $\frac{7}{2}$ respectively. (auth)

17893 MEASUREMENT OF THE STATIC QUADRUPOLE MOMENTS OF THE FIRST 2^+ STATES OF ^{108,110}Pd AND ^{110}Cd. Harper, R. P.; Christy, A.; Hall, I.; Naqib, I. M.; Wakefield, B. (Univ. of Liverpool). Nucl. Phys.; A162: 161-72(1971).

By measurement and comparison of the probabilities of Coulomb excitation by ^{4}He and ^{16}O ions of the first excited 2^+ states of ^{108,110}Pd and ^{110}Cd, the static quadrupole moments of these states were deduced. From these and earlier measurements on ^{104,106}Pd it is found that the magnitudes of the quadrupole moments increase across the Pd isotopes in the manner of a vibrator-rotor transition. (auth)

17894 THE ALPHA DECAY OF ^{179}Hg AND ^{178}Hg. Hansen, P. G. (CERN, Geneva); Jonson, B.; Zylicz, J.; (and others). Nucl. Phys.; A160: 445-8(1971).

The half-lives of the isotopes ^{179}Hg and ^{178}Hg are 1.09 ± 0.04 and 0.47 ± 0.14 s, respectively. The alpha energy for ^{178}Hg is 6425 ± 15 keV. The alpha branching ratio for the isotope ^{175}Pt was determined to be 75 ± 15%. (auth)

17895 THE ROTATIONAL SPECTRUM OF ^{161}Ho. Rensfelt, K.-G.; Johnson, A.; Hjorth, S. A. (Research Inst. for Physics, Stockholm). Nucl. Phys.; A156: 529-40(1970).

Transitions within the rotational bands built on the intrinsic states $\frac{1}{2}^+[411]$ and $\frac{7}{2}^-[523]$ in ^{161}Ho were observed when a ^{159}Tb target was bombarded with 30-MeV α particles. The observed rotational energies and relative transition probabilities indicate that the $\frac{7}{2}^-[523]$ rotational band is strongly perturbed. A calculation in which the Coriolis force mixes the orbitals $\frac{1}{2}^-[550]$, $\frac{3}{2}^-[541]$, $\frac{5}{2}^-[532]$, $\frac{7}{2}^-[523]$, $\frac{9}{2}^-[514]$ and $\frac{11}{2}^-[505]$ can successfully reproduce the experimental observations if the Coriolis interaction which is predicted by the simple rotor model is artificially reduced by about 40% for the orbitals which are close to the Fermi surface. (auth)

17896 TWO-NEUTRON DECAY OF NUCLEI. Berlovich, E. E.; Golubev, O. M.; Novikov, Yu. N. (Ioffe Inst. of Physics and Tech., Moscow). JETP Lett. (USSR) (Engl. Transl.); 12: 195-8(20 Sep 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 289-93(20 Sep 1970).

Double emission of neutrons from the ground state of nuclei is considered. It turns out that an even-N nucleus may be stable against the emission of one neutron but unstable with respect to two-neutron decay. It is concluded that, on the basis of energy considerations, there are over 150 nuclides which should show double-neutron decay. This process may be seen "pure," i.e., without accompaniment by successive neutron emission, if the spin of the emitted neutrons is sufficiently high. (R.W.R.)

17897 HIGH-RESOLUTION GAMMA AND X-RAY SPECTROSCOPY ON UNSEPARATED FISSION PRODUCTS. Wilhelmy, Jerry Barnard. Berkeley, Calif.; Univ. of California (1969). 369p. University Microfilms Order No. 70-17,685.

Thesis.

X-ray and γ-ray studies were made on the short-lived products formed from the spontaneous fission of ^{252}Cf. The fission fragments from an ~10-μg source of ^{252}Cf (3.7×10^8 fissions/minute) were embedded in a continually-moving belt system and transported past a detection point located some 19 inches from the source. By varying the velocity of the tape, spectra were obtained for transit times ranging from 0.27 seconds to 4.8 hours. Three individual experiments were performed: K-x-ray—γ-ray coincidence studies, high-resolution γ-ray singles studies, and high-resolution K-x-ray singles studies. In the coincidence studies it was possible to follow the decay of approximately 200 transitions and, through the x-ray energies, establish the element emitting the gamma ray for a large number of these. For the γ-ray singles studies 20,000 individual γ-ray peaks were analyzed at the various experimental transit times. From the K-x-ray singles measurements it was possible to determine the quantitative K-x-ray yields as a function of time for all the elements appreciably populated from the fission of ^{252}Cf (rubidium—europium). The data from the γ-ray singles experiment were correlated with information from the x-ray—γ-ray coincidence study, the studies on the prompt radiations from the primary fragment, and the reported literature on the decay of fission products. It was possible to assign ~250 of the observed transitions to specific isotopes. New assignments are made to 25 isotopes which were previously unreported or had only been identified by half life. By following the genetic decay of certain transitions it was possible to deduce charge distribution information on twelve mass chains. Finally, strong experimental information is presented for the existence of the proposed new region of permanent deformation near ^{110}Ru. (Diss. Abstr. Int. B.)

17898 SEARCH FOR TERNARY FISSION IN ^{197}Au, ^{209}Bi, AND ^{239}Pu INDUCED BY INTERMEDIATE ENERGY ^{4}He IONS. Uhl, Dale Lynden. Lafayette, Ind.; Purdue Univ. (1970). 206p. University Microfilms Order No. 70-18,759.

Thesis.

Absolute cross sections for the formation of ^{28}Mg, ^{66}Ni, and ^{89}Sr fission products and upper limits for ^{47}Ca and ^{38}S fission products were determined radiochemically. The ^{28}Mg cross-section data and the ^{47}Ca upper limits clearly indicate the existence of ternary fission in ^{209}Bi and ^{239}Pu. Ternary and binary mass-yield curves for ^{209}Bi and ^{239}Pu are constructed, and an excitation function for the formation of ^{28}Mg from ^{209}Bi is determined from an excitation energy of 30 to 50 MeV. No evidence is found for the ternary fission of ^{201*}Tl up to an excitation energy of 45.6 MeV. With the ^{28}Mg cross sections as a ternary-fission monitor, ternary-fission data at 35.4 and 45.6 MeV excitation energies were correlated as functions of Z^2/A and x, the fissionability parameter. The correlation with fissionability parameter indicates a linear increase in ternary fission above x = .67 and a decrease of ternary fission probability below x = .67. The decrease of ternary fission probability is compared with fission theory and may substantiate the present fission theory which predicts two types of saddle-point shapes. (Diss. Abstr. Int. B.)

17899 SHORT-LIVED DELAYED GAMMA-RAY EMISSION FROM FAST FISSION OF PLUTONIUM. Moore, Billy Merle. Albuquerque, N. Mex.; Univ. of New Mexico (1970). 90p. University Microfilms Order No. 70-19,707. Thesis.

The short-lived delayed gamma spectra from fast neutron fission of plutonium were experimentally measured by using a Ge(Li) detector. The half-lives and energies of the more prominent gamma rays in the spectra were determined for half-lives in the range 1 min $\leq t_{\frac{1}{2}} \leq$ 60 min and for energies in the range 170 keV $\leq$ E $\leq$ 1800 keV. From the delayed gamma spectra, yields were determined for the shortlived fission products ^{87}Rb, ^{92}Rb, ^{94}Sr, ^{94}Y, ^{101}Mo, ^{101}Tc, ^{131}Sb, ^{135m}Xe, ^{136}I, ^{137}Xe, ^{138}Xe, and ^{138}Cs. Minimum estimates of the yields were determined for ^{90}Y, ^{104}Tc, ^{139}Xe, ^{145}Cs, and ^{145}Ce. Also the delayed gamma spectra from fast fission of ^{239}Pu were compared to that obtained from fast fission of ^{235}U. From the results obtained, conclusions could be reached on what fission products would produce the largest differences in the two spectra at high energy. This particular information is needed to help keep fuel inventory in reactors. This will protect against the unwarranted use of nuclear fuels that are produced in reactors (safeguards). (Diss. Abstr. Int., B.)

17900 HYPERFINE INTERACTION STUDIES OF HEAVY NUCLEI IN HIGHLY IONIZED ATOMS. Ben-Zvi, I.; Gilad, P.; Goldberg, M. B.; Goldring, G.; Speidel, K.-H.; Sprinzak, A. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A151: 401-19(1970).

A detailed and extensive study of the hyperfine interaction of nuclei with highly ionized atoms in gas is reported. Some new and unexpected features of the interaction are discussed. These relate to the pressure dependence of the perturbation, its variation with Z and dependence on recoil velocity; g-factors of 2^+ levels were determined for nuclei in the mass range: 148 $\leq$ A $\leq$ 190. (auth)

17901 THORIUM FISSION BY 4.8- AND 14-MeV NEUTRONS. Pfeiffer, E. (Univ., Tuebingen, Ger.). Z. Phys.; 240: 403-19(1970).

The fission of natural thorium by E_n = 4.8- and 14.0-MeV neutrons was investigated by measuring the kinetic energies of both fragments in surface-barrier detectors. The fragments were detected for E_n = 14.0 MeV neutron energy at 90° to the neutron beam; and for E_n = 4.8 MeV, at 0 and 90°. The results given are the distributions of mass and of energy correlative to the fragment mass, and the correlation between anisotropy and fragment mass at E_n = 4.8 MeV. The average total kinetic energy before prompt neutron emission at E_n = 4.8 and 14.0 MeV neutron energy was found to be $\overline{E_K^*}$ = 170.47 ± 0.03 and 168.1 ± 0.05 MeV, respectively. Within the limits of statistical error the anisotropy at E_n = 4.8 MeV is independent of the fragment mass. The results are analyzed in the framework of the Two-Mode-Fission-Hypothesis. It appears that the behavior of the kinetic energy is too complicated as to be well described by the Two-Mode-Fission-Hypothesis. Both the Cluster Model of fission and the Fragment Shell Theory are suited to reproduce qualitatively the observed energetics of fission. (auth)

17902 INVESTIGATION OF THE LEVEL STRUCTURE OF ^{93}Nb BY MEASUREMENT OF THE GAMMA RAYS EMITTED AFTER THE INELASTIC SCATTERING OF FAST NEUTRONS. Goebel, H.; Feicht, E. J.; Vonach, H. (Technische Hochschule, Munich). Z. Phys.; 240: 430-53(1970). (In German).

Fast neutrons from a nanosecond-pulsed D(d,n)^{3}He neutron source were scattered from ^{93}Nb. The gamma spectrum arising from inelastic scattering was measured in a high-resolution Ge(Li) spectrometer. In order to obtain low background a time gate technique was used. About 44 gamma lines could be found between 150 keV and 2.2 MeV in the singles spectrum. In addition, gamma-gamma coincidences were investigated with a NaI and a Ge(Li) detector. By these means it was possible to identify almost all gamma transitions and to construct a nearly complete level scheme of ^{93}Nb up to 2.2 MeV. The experimental cross sections for the population of the levels by the (n,n′) reaction were compared with the results of the Hauser–Feshbach theory using the optical-model transmission coefficients of Lindner and Meldner. From this and from the observed gamma transitions proposals for spin and parity assignments of the energy levels are given. (auth)

17903 g FACTOR OF THE 50-keV $3/2^-$ STATE IN ^{223}Ra AND THE INTERNAL MAGNETIC FIELDS AT Ra NUCLEI IN FERROMAGNETS. Levanoni, M.; Zawislak, F. C. (California Inst. of Tech., Pasadena). Phys. Rev., C; 2: 672-4(Aug 1970).

The γ-γ perturbed angular correlation of the 236–50-keV cascade in ^{223}Ra has been investigated, yielding $g(3/2^-, 50\ keV)$ = +0.28 ± 0.04. The magnetic hyperfine fields experienced by Ra nuclei embedded in Ni, Co, and Fe lattices were found to be –30 ± 10, –80 ± 16, and –105 ± 20 kOe, respectively. (auth)

17904 COULOMB EXCITATION OF Pt NUCLEI. Bruton, E. J.; Cameron, J. A.; Gibb, A. W.; Kenyon, D. B.; Keszthelyi, L. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A152: 495-502(1970).

Coulomb excitation of the second excited states of ^{192}Pt and ^{194}Pt gave B(E2, $0^+ \rightarrow 2^{+\prime}$) values of 0.020(3) and 0.0111(17) $e^2 \cdot b^2$ respectively. The 199.3 keV level of ^{195}Pt was excited and assigned spin and parity $3/2^-$. The B(E2) values for other excitations in the Pt isotopes were remeasured. A comparison of the results with theoretical values and directly measured lifetimes has been made. Measured g-factors have been re-evaluated and compared with theoretical predictions. (auth)

17905 INELASTIC SCATTERING OF TRITONS AND PROTONS FROM ^{210}Pb. Ellegaard, C. (Carnegie-Mellon Univ., Pittsburgh); Barnes, P. D.; Flynn, E. R.; Igo, G. J. Nucl. Phys.; A162: 1-11(1971).

A search for collective states in ^{210}Pb was conducted utilizing inelastic scattering of 20-MeV tritons and 20.5-MeV protons. In the triton scattering, cross sections were obtained for levels at 0.795, 1.87, and 2.83 MeV. The 0.795 level is a known 2^+ level. It is excited with a cross section of one-half of that observed for the first 2^+ level of ^{208}Pb under identical conditions. The two other states are assigned as 3^- states. The cross sections obtained for these two levels are approximately $2/3$ and $1/3$ of the cross section found in the (t,t′) reaction for the first 3^- state of ^{208}Pb. In the proton scattering, the above results are confirmed and several other levels observed. The results are compared with DWBA calculations. (auth)

17906 NOTE ON THE ^{101}Tc–^{101}Ru DECAY. Siwamogsatham, B.; Easterday, H. T. (Oregon State Univ., Corvallis). Nucl. Phys.; A162: 42-8(1971).

The gamma spectrum resulting from the 14.0-min decay of ^{101}Tc to levels of ^{101}Ru has been examined. The level of ^{101}Ru at 616.3 keV not previously found in the ^{101}Tc decay but observed in Coulomb excitation has been observed in this study. In addition, evidence for new levels at 674.2, 911.9, 938.1 and 1001.1 keV is presented. Fourteen gamma transitions, which previously were not observed or were indicated only in coincidence spectra, are reported. (auth)

17907 STRUCTURE OF ^{169}Tm AND ^{171}Tm NUCLEI AND CORRECTIONS TO THE UNIFIED MODEL. Hsu, Hsiao-hua. Bloomington, Ind.; Indiana Univ. (1970). 77p. University Microfilms Order No. 70-17,956.

Thesis.

The structure of the nuclei ^{169}Tm and ^{171}Tm is studied in terms of the unified nuclear model of Bohr, Mottelson, and Nilsson. The Nilsson states [411↓], [404↓], and [523↑] were observed in both nuclei. The structures of the ground-state rotational bands (based on [411↓]) of the two nuclei resemble each other in general, but differ in detail; for example, the decoupling factors are different by about ten per cent. The single-proton energy of the [404↓] band changes dramatically from ^{169}Tm to ^{171}Tm. These changes in structure cannot be explained by the conventional unified model even if the change in deformation is taken into account. Since the major difference between these two nuclei is the two extra neutrons in ^{171}Tm, the data suggest that the interaction of the unpaired proton with these two added neutrons must play an important role in the structure of ^{171}Tm. A delta-function type proton–neutron interaction is introduced into the Nilsson-model Hamiltonian as a first perturbation term. The new Nilsson wave functions and single-particle energies are calculated, and the decoupling constant and magnetic parameters b_0 and g_k are derived. The results of the calculation agree well with the experimental results. (Diss. Abstr. Int. B.)

17908 DETERMINATION OF THE STATIC AND DYNAMIC ELECTRIC QUADRUPOLE MOMENTS OF THE FIRST 2^+ STATES IN ^{188}Os, ^{190}Os, AND ^{192}Os BY MEANS OF COULOMB EXCITATION. Pryor, Richard Joseph. Pittsburgh; Univ. of Pittsburgh (1970). 82p. University Microfilms Order No. 70-19,498.

Thesis.

The ratio of inelastically scattered ions exciting the first 2^+ state to elastically scattered ions was measured using an Enge split-pole spectrograph and position-sensitive solid-state counters. Measurements were performed at various angles and energies using ^{4}He and ^{16}O beams. The static electric-quadrupole moment Q_{2^+} and the B(E2, $0^+ \rightarrow 2^+$), which are functions of the ratios, were determined using the Winther–de Boer Coulomb-excitation program and a least-squares code. The deduced static electric-quadrupole moments of the first 2^+ state are –1.31 ± .34 eb, –.99 ± .13 eb, and –.41 ± .20 eb for ^{188}Os, ^{190}Os, and ^{192}Os, respectively. The B(E2, $0^+ \rightarrow 2^+$) values for these same nuclei are 2.90 ± .08 e^2b^2, 2.39 ± .06 e^2b^2, and 2.04 ± .06 e^2b^2, respectively. These results are compared with recent model calculations and found to be in good agreement with the predictions. (Diss. Abstr. Int. B.)

17909 MEASUREMENTS OF STATIC ELECTRIC QUADRUPOLE MOMENTS AND TRANSITION PROBABILITIES IN THE REGION OF A = 144 TO 150. Gertzman, Henry Steven. New York; Univ. of Rochester (1970). 255p. University Microfilms Order No. 70-17,881.

Thesis.

The Coulomb-excitation reorientation effect was used to measure the static electric-quadrupole moments of the first 2^+ states in ^{148}Sm, ^{144}Nd, ^{146}Nd, ^{148}Nd, and ^{150}Nd. Results were also obtained for the B(E2, $0^+ \rightarrow 2^+$) of ^{148}Sm. Assuming a positive sign for the interference term gives the results B(E2, $0^+ \rightarrow 2^+$) = 0.706 ± 0.024 e^2b^2 and Q_{2^+} = +0.28 ± 0.28 eb for the 551-keV state. A negative interference term gives B(E2, $0^+ \rightarrow 2^+$) = 0.705 ± 0.025 e^2b^2 and Q_{2^+} = –0.24 ± 0.28 eb. An analysis was made to determine the value for the static quadrupole moment of ^{150}Nd that would result in the best agreement between the relative quadrupole moments measured in the present experiment and values previously measured. Best agreement was obtained by assuming Q_{2^+} = –2.00 ± 0.51 eb for ^{150}Nd. The best values for the quadrupole moments of ^{144}Nd, ^{146}Nd, and ^{148}Nd, corresponding to the above value for ^{150}Nd, are –0.07 ± 0.15, –.78 ± .09, and –1.46 ± 0.13 eb, respectively. These correspond to 11%, 99%, 138%, and 136% (for ^{150}Nd) of the rotational values based upon previously published values for the B(E2)'s. The evidence shows a smooth transition from small quadrupole moments for nuclei near N = 82 to large negative quadrupole moments as one adds pairs of neutrons (or neutron holes). (TSS) (Diss. Abstr. Int. B.)

17910 MEASUREMENTS OF THE STATIC QUADRUPOLE MOMENT OF THE FIRST EXCITED STATE OF THE NUCLEI ^{106}Pd AND ^{110}Pd BY HEAVY ION COULOMB EXCITATION. Beyer, Robert William. Lafayette, Ind.; Purdue Univ. (1970). 226p. University Microfilms Order No. 70-18,596.

Thesis.

XUM

The static quadrupole moments of the 511.7-keV 2^+ state in ^{106}Pd and the 373.8-keV 2^+ state in ^{110}Pd were determined by employing Coulomb excitation techniques. Thin foils (~175 $\mu g/cm^2$) of separated-isotope Pd were bombarded with 25 and 30 MeV ^{16}O ions and 55 and 56 MeV ^{32}S ions. The angular distributions of the inelastically scattered ions were measured in coincidence with the de-excitation gamma rays to determine the relative excitation probability. The attenuations of the de-excitation-gamma-ray distributions were measured. The experimental data were fitted using the deBoer–Winther Multiple Coulomb Excitation Program so that the sign and magnitude of the static quadrupole moment could be extracted. The effect of higher excited states on the excitation probability on the 2^+ state is estimated using the matrix elements determined by Robinson et al. and the deBoer–Winther Program. Self consistency of the oxygen and sulfur data suggests that excitation via the giant dipole resonance must be small compared to the reorientation effect, and that the excitation via the second 2^+ states at 814 keV in ^{110}Pd and 1127 keV in ^{106}Pd interferes constructively so as to increase the excitation probability. With this choice for the interference via the second 2^+ state the values of the static quadrupole moments are $Q_{22} = -.458 \pm .059$ barns for ^{106}Pd and $Q_{22} = -.483 \pm .049$ barns for ^{110}Pd. (Diss. Abstr. Int. B.)

17911 j DEPENDENCE IN THE VECTOR ANALYZING POWER FOR ^{208}Pb(d,t)^{207}Pb. Liers, H. S.; Rathmell, R. D.; Vigdor, S. E.; Haeberli, W. (Univ. of Wisconsin, Madison). Phys. Rev. Lett.; 26: 261-3(1 Feb 1971).

A vector-polarized deuteron beam of 12.3 MeV was used to measure differential cross sections and vector analyzing powers for the reaction ^{208}Pb(d,t), leading to the $p_{\frac{1}{2}}$ ground state, $f_{\frac{5}{2}}$ first excited state, and $p_{\frac{3}{2}}$ second excited state of ^{207}Pb. The vector analyzing powers for the two l = 1 transitions differ strikingly. This j dependence is well reproduced by distorted-wave Born-approximation calculations. (auth)

17912 EXPLANATION OF SOME STRIPPING TRANSITIONS TO UNBOUND ISOBARIC ANALOG STATES. Cole, B. J.; Huby, R.; Mines, J. R. (Univ. of Liverpool). Phys. Rev. Lett.; 26: 264-6(1 Feb 1971).

Several (^{3}He,d) and (d,n) transitions on Zr and Mo targets leading to unbound isobaric analog states that have previously been reported anomalous in comparison with distorted-wave Born-approximation predictions are recalculated using a different form-factor prescription. Since broad overall agreement with experiment is obtained, both the nuclear structure and the reaction mechanism are apparently normal. (auth)

17913 PAIRING-PLUS-QUADRUPOLE MODEL CALCULATION OF BAND-MIXING ANOMALIES IN ^{152}Sm. Kumar, Krishna (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 26: 269-72 (1 Feb 1971).

The pairing-plus-quadrupole model is improved and extended to I = 6 states. This microscopic theory gives the parameters of the first-order band-mixing theory of Bohr and Mottelson, as well as most of the higher-order corrections revealed by the recent measurements of E2 matrix elements. The increase in the intra-ground-band transitions and the depression of the ground-band levels compared with their rotational-model values are reproduced. (auth)

17914 TOTAL CROSS SECTIONS OF HEAVY ELEMENTS FOR 100- TO 150-MeV NEUTRONS. Schneider III, Robert Julius. Medford, Mass.; Tufts Univ. (1968). 102p. University Microfilms Order No. 70-16,920.

Thesis.

The neutron total cross sections were measured to an accuracy of one percent for a series of five elements at six different incident-neutron energies. The elements were aluminum, copper, cadmium, lead, and uranium. The energies ranged from 100 MeV to 150 MeV in 10 MeV steps, with an energy resolution of one MeV. The measured total cross sections, together with published nonelastic cross sections, are analyzed in terms of the nuclear optical model. The real and imaginary parts of the central nuclear potential were determined at each energy. It was found that no single set of radial parameters was optimum for all energies. Both the cross sections and the potentials extrapolate well to the values measured previously up to 100 MeV. (Diss. Abstr. Int., B)

17915 EPICADMIUM INTEGRAL FISSION CROSS SECTION MEASUREMENTS FOR TWELVE HEAVY NUCLIDES. Draper, Ernest Linn Jr. Ithaca, N. Y.; Cornell Univ. (1970). 140p. University Microfilms Order No. 70-14,377.

Thesis.

Epicadmium energy integral fission rates given by $FR = \int_{E_{cd}}^{\infty} \sigma_f(E)\,\phi(E)\,dE$ for ^{232}Th, ^{233}U, ^{235}U, ^{236}U, ^{238}U, ^{237}Np, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{241}Am, ^{242m}Am, and ^{243}Am were measured in a neutron beam. The energy spectrum of the neutron beam was altered from the fission slowing-down spectrum used for the first set of measurements by the insertion of three different thicknesses of ^{10}B filter. The shapes and amplitudes of the four spectra were determined by the computer code SAND II to reproduce the interaction of the neutrons with a set of resonance and threshold detector foils. The fission rates were determined by counting fission-fragment tracks produced in solid-state track recorders. The measured fission rates were compared to fission rates calculated using the four SAND II spectra and differential $\sigma_f(E)$ data from the literature. The measured and calculated fission rates differed by less than 7% for ^{232}Th, ^{233}U, ^{235}U, ^{236}U, ^{238}U, and ^{237}Np. There is evidence that the ^{232}Th, ^{238}U, and ^{237}Np data need slight normalization corrections. ^{239}Pu showed positive deviations of measured from calculated activities of from about 4 to 10% depending on the spectrum. ^{240}Pu had measured fission rates from 7.5 to 12% greater than calculated while ^{241}Pu measurements ranged from about 6 to 10% lower than calculated. ^{241}Am had a substantial deviation only in the softest spectrum; this indicates a possible differential-cross-section error in the eV region. ^{242m}Am had large positive deviations of measured from calculated activities in all spectra, but nonuniformity of the deposit made it impossible to specify the reason for these deviations. ^{243}Am had measured fission rates approximately 60% higher than calculated in all spectra. This indicates either a large normalization error in $\sigma_f(E)$ or a serious mistake in the foil assay (Diss. Abstr. Int., B)

17916 INTERNAL CONVERSION PROCESSES FOR ELECTRIC QUADRUPOLE TRANSITIONS IN THE DEFORMED NUCLEAR REGION. Burton, Donald Eugene. Manhattan, Kan.; Kansas State Univ. (1970). 285p. University Microfilms Order No. 70-16,621.

Thesis.

The K-shell internal conversion coefficients, L-subshell ratios, and second-order K- and L-shell particle parameters are presented for eleven $2^+ \rightarrow 0^+$ transitions in the rare-earth and neighboring regions. These quantities are calculated in the no-penetration approximation using the relativistic Hartree–Fock atomic model in the Slater exchange approximation with the inclusion of static finite-nuclear-size effects. Results are presented for ^{152}Gd, ^{154}Gd, ^{156}Gd, ^{160}Dy, ^{166}Er, ^{170}Yb, ^{172}Yb, ^{186}Os, ^{188}Os, ^{192}Os, and ^{198}Hg. Comparison of the present calculations with the weighted averages of the available experimental values indicates that substantial discrepancies exist between the two. It is shown that most of these can be accounted for on the basis of either dynamic E2 penetration effects or parity-nonconserving nuclear forces. In the first case, it is found that the dynamic E2 penetration parameters must be several times the values predicted by the surface-current model. If, on the other hand, parity-nonconserving nuclear forces are the cause of the discrepancies, then conversion-electron longitudinal polarizations of 5 to 30 percent can be expected. (Diss. Abstr. Int., B)

17917 EMISSION OF LONG-RANGE ALPHA PARTICLES IN THE FISSION PROCESS. Bethune, Glen Roberts. Gainesville, Fla.; Univ. of Florida (1969). 157p. University Microfilms Order No. 70-14,855. Thesis.

The properties of the long-range alpha particles emitted in the thermal-neutron fission of ^{235}U (LRA fission) were examined in a three-parameter correlation experiment. Three semiconductor detectors in conjunction with triple coincident electronic equipment and a multiparameter analyzer made it possible to detect simultaneously the two fission fragments and the alpha particle from a ternary event and to analyze the energy of the three particles. Data were collected for eight values of θ_L, the angle between the alpha particle and the direction of the light fission fragment, over a range of 40 to 145 degrees. These data allowed a solution of the momentum conservation equations for the two fission fragment masses. The general characteristics of the alpha particles are presented in the form of the measured angular and energy distributions. Also shown, for each value of θ_L, are the alpha-particle kinetic-energy distributions, the fission-fragment kinetic-energy distributions, the total-kinetic-energy distributions, and the fission-fragment mass distributions, as well as average values for the alpha-particle kinetic energy, the light- and heavy-fission-fragment kinetic energy, the total fission-fragment kinetic energy, and the total kinetic energy released in the process. The results show that the average energy of the fission fragments in LRA fission is about 155 MeV and does not vary with the emission angle of the alpha particle, the total kinetic energy (alpha particle plus fission fragments) in LRA fission is about 3.5 MeV greater than the kinetic energy of the fragments in binary fission, the yield of symmetric or near-symmetric fission is more probable in LRA than in binary fission and becomes considerable at the extreme angles, and the average kinetic energy of the alpha particle increases with the extremity of the emission angle. These results are interpreted in an attempt to formulate a descriptive model for the LRA fission process. (Diss. Abstr. Int., B)

17918 FISSION BARRIERS AND TRANSITION-STATE SPECTRA FOR ^{232}Th, ^{234}Th, ^{238}U, ^{240}U, ^{242}Pu, AND ^{244}Pu FROM (t,pf) REACTIONS. Cramer, James D. Albuquerque, N. Mex.; Univ. of New Mexico (1969). 122p. University Microfilms Order No. 70-16,382.

Thesis.

Fission probabilities and the angular distribution of the fission fragments were measured for six even–even compound-nucleus systems using the (t,pf) reaction. Angular correlations of fission fragments obtained in these experiments provide information about the low-lying collective excitations or transition states at the fission barrier. The experimental data were obtained using an 18-MeV triton beam on targets of ^{242}Pu, ^{240}Pu, ^{238}U, ^{236}U, ^{232}Th, and ^{230}Th. Outgoing protons were detected at 140° relative to the incident triton beam. Excitation energies ranging from 3.0 to 9.0 MeV were obtained in these experiments. Fission-fragment angular distributions were measured at 24 angles from 0° to 140° relative to the kinematic recoil angle. The data were fitted to a series of even Legandre polynomials, $W(\theta) = A_0[1 + \Sigma/L\ g_L P_L^{(\cos\theta)}]$, and the coefficients g_2 through g_{12} and A_0 were determined as a function of excitation energy. The fission probability P_f was obtained from the ratio of A_0 to the (t,p) cross section for the target nucleus. The results exhibit well-defined structure in the angular coefficients which correlates with structure in the fission probability for most of the nuclei studied. The experimentally determined fitting parameters P_f and g_L are compared to calculated results of a microscopic model. This model takes into consideration the penetrability and angular dependence of fission through each member of the various transition bands at the saddle point and appropriately sums the results for comparison with the data. The effects of barrier penetration through a two-peaked deformation potential are incorporated into this analysis. Characteristics of transition-state spectra and fission barrier shapes determined from this analysis are presented with respect to variations of the fissility parameters. (TSS) (Diss. Abstr. Int., B)

17919 MEASUREMENTS OF TIME-DEPENDENT ENERGY SPECTRA OF BETA RAYS FROM ^{235}U FISSION FRAGMENTS. Tsoulfanidis, N.; Wehring, B. W.; Wyman, M. E. (Univ. of Illinois, Urbana). Nucl. Sci. Eng.; 43: 42-53(Jan 1971).

Absolute measurements have been reported for the time-dependent beta-energy spectra from fission fragments for electron energies >0.75 MeV. The fragments were produced in the thermal-neutron fission of ^{235}U. To obtain results for electron energies below 0.75 MeV and to provide overlap with the previous results, absolute measurements were made of the time-dependent energy spectra using an experimental system specifically designed for the electron-energy range of 0.1 to 1.0 MeV. In this system, a vacuum chamber housed a thin plastic scintillator for the detection of the low-energy electrons, a source foil which was fissioned in a thermal-neutron beam, and a surface-barrier detector for the monitoring of the fission rate. The source foil consisted of 10.4 mg/cm^2 of ^{235}U covered and sealed to form a localized source of fission fragments. A deposit of 138 μg/cm^2 of ^{235}U on the outside of this foil facing the surface-barrier detector provided the fission fragments for the monitor. Electron energy spectra were measured for the cases of spectrum build-up after initiation of a constant fission rate in a clean foil, spectrum decay after termination of 8 h of a constant fission rate, and spectrum decay following a sudden burst of fission produced by a reactor power pulse. The resulting spectra were corrected for the effects of energy resolution and source thickness by unfolding them with the use of a measured system response function. The time-dependent energy measurements for the low-energy betas were combined with the previous measurements for the high-energy betas, and the results are presented in tables and graphs. Also given are the total number of betas per fission and the total beta energy per fission for various times during the build-up or the decay of the spectra. Comparisons are made with previous experimental and theoretical work. (auth)

17920 RATIOS OF THE FAST-NEUTRON FISSION CROSS SECTIONS OF ^{235}U, ^{239}Pu, AND ^{240}Pu. Savin, M. V.; Khokhlov, Yu. A.; Zamyatnin, Yu. S.; Paramonova, I. N. At. Energ. (USSR); 29: 218-20(Aug 1970). (In Russian).

In order to clarify previously observed irregularities in the energy dependence of the fission-cross-section ratios, the dependence of $\sigma_f(^{239}\text{Pu})/\sigma_f(^{235}\text{U})$ and $\sigma_f(^{240}\text{Pu})/\sigma_f(^{235}\text{U})$ was measured in the 0.7- to 5-MeV range by the time-of-flight method. A lead target served as the neutron source; the neutron beam was directed on the specimen, placed at the center of a liquid scintillation counter. The fission events were recorded on the basis of the prompt-fission γ quanta. The experiment consisted of individual measurements with and without the lead specimen, with the effect of elastic and inelastic scattering taken into account for the first case. In the error determination the statistical errors, the instability of the neutron monitor, the presence of impurity isotopes, and similar factors were taken into account. In the case of ^{240}Pu, the results in the 1- to 2-MeV range were found to differ by ~8% from Davey's data; they agreed with the values reported by Nesterov et. al. In the 0.8- to 2.5-MeV range, this deviation repeats the previously observed irregularities in the behavior of the $^{38}\alpha_f/^{35}\alpha_f$ function. (TTT)

17921 NEW ISOTOPE ^{173}Er. Ihochi, Haruhiko. Fayetteville, Ark.; Univ. of Arkansas (1970). 75p. University Microfilms Order No. 70-17,182.

Thesis.

Irradiations of natural ytterbium and enriched ^{176}Yb samples were found to produce a new radioactive nuclide which was assigned to ^{173}Er. The following radiation characteristics were observed to belong to the decay of ^{173}Er: half-life 12.0 ± 0.3 minutes; beta-ray energies 1.8 ± 0.3 and 2.3 ± 0.3 MeV, and relative intensities 30 ± 3 and 70 ± 5, respectively; gamma-ray energies 0.087 ± 0.005, 0.100 ± 0.005, 0.115 ± 0.005, 0.128 ± 0.005, 0.155 ± 0.005, 0.182 ± 0.005, 0.197 ± 0.005, 0.205 ± 0.005, 0.278 ± 0.005, 0.300 ± 0.005, 0.365 ± 0.005, 0.380 ± 0.005, 0.395 ± 0.005, and 0.520 ± 0.005 MeV, and relative intensities 10.3 ± 1.0, 6.7 ± 0.5, 7.0 ± 3.5, 4.0 ± 0.5, 18.4 ± 2.5, 20.0 ± 2.0, 59.5 ± 4.0, 4.0 ± 0.6, 5.0 ± 0.8, 3.0 ± 0.5, 18.5 ± 2.0, 19.5 ± 2.0, 30.0 ± 5.0, and 20.0± 3.0, respectively. A decay scheme is proposed for the decay of ^{173}Er, and the K = ½ anomalous rotational bands of ^{173}Tm are investigated in terms of the unified model. (Diss. Abstr. Int., B)

17922 GAMMA-RAY SPECTROSCOPY STUDIES OF THE EXCITED STATES OF ODD PROTON (ODD MASS) NUCLEI IN THE Z = 50 TO 62, N = 64 TO 82 REGION. Beery, Dwight Beecher. East Lansing, Mich.; Michigan State Univ. (1969). 196p. University Microfilms Order No. 70-14,988.

Thesis.

The beta, gamma decay schemes of ^{141m,g}Nd, ^{139m,g}Nd, ^{137m,g}Ce, ^{133m}Ba, and ^{131m}Ba were studied in an effort to acquire information about the energy-level systematics in this region of the table of nuclides. Ge(Li) singles and Ge(Li)–NaI(Tl) coincidence spectrometers were employed to identify and establish the sequence of many new gamma-ray transitions. Some significant additions to, and changes from, previously proposed schemes are suggested by the data. Excited levels accommodating 10 gamma rays have been located at 145.4, 1126.8, 1292.5, 1298.4, 1580.0, 1607.9, and 1657.2 keV in ^{141}Pr following the decay of 2.6-h ^{141g}Nd. States in ^{139}Pr at 113.8, 405.0, 589.2, 916.8, 1074.4, 1311.8, 1328.2, 1405.5, 1449.5, and 1501.2 keV are populated by 30-min ^{139g}Nd while the decay of 5.5-h ^{139m}Nd populates levels at 113.8, 821.9, 828.1, 851.9, 1024.0, 1369.6, 1523.2, 1624.5, 1834.1, 1927.1, 2048.8, 2174.3, and 2196.7 keV. These two sets of states incorporate 17 and 38 transitions, respectively. The 19 gamma rays seen in the decay of 34.4-h ^{137m}Ce in equilibrium with 9.0-h ^{137g}Ce depopulate excited states of ^{137}La at 10.5, 447.1, 493.1, 709.1, 762.2, 781.5, 835.4, 926.6, 1004.8, and 1171.9 keV. Of these levels, only those at 762.2, 835.4, and 1004.8 keV are populated directly by ^{137m}Ce, and none of these states is populated by both isomers. Only one state of ^{133}Cs was seen to be directly populated by 38.9-h ^{133m}Ba, and an upper limit of 0.1% of the 14.6-min ^{131m}Ba disintegrations is placed on the direct feeding to high spin states of ^{131}Cs with energies >60 keV. Limits on the possible spin assignments of the states investigated are placed from calculated log-ft values and from the presence of transitions to states with known spins. A multiplet of six high-spin, odd-parity states near 2 MeV in ^{139}Pr is interpreted as a set of three-quasi-particle states. The multiplet decay pattern suggests the possibility that information can be extracted from these states that is normally available only for lower-lying levels. A survey is made of all of the energy-state systematics of the low-energy levels of odd-proton (odd-mass) nuclides in the Z = 50 to 62, N = 64 to 82 region. (Diss. Abstr. Int., B)

17923 PRECISE MEASUREMENTS OF GAMMA-RAY ENERGIES AND INTENSITIES WITH APPLICATION TO THE DECAYS OF ^{108m}Ag, ^{110m}Ag, ^{95}Zr, AND ^{99}Mo. Brahmavar, Suresh Marutirao. Nashville; Vanderbilt Univ. (1970). 95p. University Microfilms Order No. 70-16,412.

Thesis.

Measurements were made of the energies of several secondary energy standards. The measured values are 834.72 ± 0.10 (^{54}Mn), 889.21 ± 0.10 (^{46}Sc), 897.90 ± 0.10 (^{88}Y), 1115.37 ± 0.10 (^{65}Zn), 1120.42 ± 0.10 (^{46}Sc), 1274.51 ± 0.10 (^{22}Na) and 1836.07 ± 0.10 (^{88}Y) keV. The measured values include remeasurement of a primary standard in ^{207}Bi (1769.71 ± 0.13 keV) and a secondary standard in ^{212}Bi (727.1 ± 0.1 keV). A search for new gamma rays yielded gamma rays assigned to ^{110m}Ag and ^{108m}Ag decay. The energies and intensities of gamma rays obtained in the decays of ^{99}Mo are given. Measurements of internal conversion coefficients with normalized electron-peak method are included. This work establishes six new gamma rays in the decays of ^{208}Tl and ^{212}Bi as energy calibration standards and ^{110m}Ag and ^{95}Zr as energy and

intensity standard sources in the energy range of 400 to 1800 keV. (TSS) (Diss. Abstr. Int., B)

17924 SEARCH FOR NEW ISLANDS OF FISSION ISOMERISM. Bjoernholm, Sven; Borggreen, Joern; Hyde, Earl K. (Univ. of California, Berkeley). Nucl. Phys.; A156: 561-9(1970).

The spontaneously fissioning isomers of Am and neighboring elements are explained as nuclei trapped in a secondary minimum in the fission barrier profile. Some recently published calculations suggest the possible existence of another group of such shape isomers near Z = 85, N = 118. An attempt was made to produce isomers of Po, At, Rn, and Fr by bombardment of ^{197}Au with beams of ^{11}B, ^{12}C, ^{14}N, ^{16}O, from the Berkeley HILAC and to observe their fission mode with Si semiconductor detectors. The cross-section limits were set at 70 nb or less for the half-life range 2×10^{-9} to 2×10^{3} s. An attempt was also made to observe fission fragments from nuclei decaying in flight after recoiling out of targets of Ce, Pr, Tm, and Au bombarded with heavy ions. No fission fragments were observed from products in the half-life range 1 to 50 ns above a cross-section limit of ≈50 nb. The possible existence of isomers decaying primarily by γ transitions to the first minimum was not excluded in either set of measurements. The apparatus was tested with known isomers produced by the reactions ^{238}U(d, pn)$-^{238m}$U (200 ns) and ^{238}U(^{12}C,α3n)^{243m}Cm (38 ns). (auth)

17925 NEGATIVE PARITY STATES IN ODD-MASS Ir AND Au NUCLEI. Baecklin, A. (Swedish Research Councils' Lab., Studsvik); Berg, V.; Malmskog, S. G. Nucl. Phys.; A156: 647-73(1970).

The decays of ^{193}Os → ^{193}Ir, ^{191}Pt → ^{191}Ir, ^{189}Pt → ^{189}Ir and ^{193}Hg → ^{193}Au were studied in $\gamma-\gamma$ coincidences, internal conversion and electron–electron delayed coincidences. New levels with the following spin-parity assignments and half-lives are proposed: ^{193}Ir: 299.45 ± 0.09 keV, $I^{\pi} = 7/2^-$, $T_{1/2} = 0.19 \pm 0.03$ ns; 598.26 ± 0.15 keV, $I^{\pi} = 3/2^-$; 740.46 ± 0.15 keV, $I^{\pi} = 5/2^-$. ^{191}Ir: 391.14 ± 0.05 keV, $I^{\pi} = 7/2^-$, $T_{1/2} = 0.24 \pm 0.02$ ns; 659.06 ± 0.08 keV, $I^{\pi} = 3/2^-$, $T_{1/2} < 0.12$ ns. ^{189}Ir: 615.70 ± 0.08 keV, $I^{\pi} = 7/2^-$, $T_{1/2} = 0.18 \pm 0.02$ ns; 1184.54 ± 0.11 keV, $I^{\pi} = 5/2^-$, $T_{1/2} < 0.08$ ns. The 508 keV $7/2^-$ level in ^{193}Au was found to have $T_{1/2} = 0.29 \pm 0.02$ ns. In each nucleus these negative parity states and the $11/2^-$ isomeric state are strongly connected with E2 and M1 transitions and only weakly connected to the low-lying positive parity states. The B(E2) values are close to the values of B(E2; $2^+ \rightarrow 0^+$) in the neighboring even nuclei. It is proposed that these negative parity level systems are associated with an essentially spherical shape of the nuclei in contrast to the low-lying positive parity states (including the ground state) of these nuclei, which in Ir are likely to be deformed states. (auth)

17926 FISSION CROSS SECTIONS OF ^{237}Np FROM POMMARD. Brown, W. K.; Dixon, D. R.; Drake, D. M. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys.; A156: 609-15(1970).

The ^{237}Np(n,f) cross section was measured from 32 eV to 2.2 keV and from 100 keV to 2.8 MeV. Energies of neutrons from the underground nuclear explosion Pommard were determined by time-of-flight from the source to the target foil located near the surface. Signals produced by fission fragments in solid-state detectors were recorded photographically. The ^{235}U(n,f) and ^{6}Li(n,α) reactions were used to measure the neutron flux. Grouped subthreshold resonances were observed. Above threshold, the cross section reached a maximum of about 1.7 b in the vicinity of 2.2 MeV. (auth)

17927 NUCLEAR CHARGE DISPERSION IN THE FISSION OF HEAVY NUCLEI BY MEDIUM-ENERGY PROTONS. Yaffe, L. (McGill Univ., Montreal). pp 3-19 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

Fission products from the fission of ^{233}U, ^{235}U, ^{238}U, ^{232}Th, and ^{239}Pu were studied with a view to elucidating the distribution of nuclear charge in fission caused by protons of energies 20 to 85 MeV. The importance of the neutron-to-proton ratio of the fissioning species is apparent. Excitation functions are shown for fission products with mass numbers A = 130 to 140. The energy at which the excitation function of these individual fission products reaches its maximum shows the dependence on nuclear constitution. Charge distribution data show the role of the neutron-to-proton ratio of the fissioning system. In general, with increasing bombarding energy, the distribution curves become broader, and the most probable charge, Z_p, moves closer to stability. The experimental values of Z_p are compared with those obtained from calculations assuming various charge distribution postulates. Some comments are made about the numbers of neutrons emitted from the various fissioning species at different excitation energies. (auth) (UK)

17928 SEARCH FOR NEW ISOTOPES AND NEW SUPER-HEAVY ELEMENTS PRODUCED BY HEAVY-ION REACTIONS. Lefort, Marc (Institut de Physique Nucleaire, Orsay, France). pp 32-41 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The production of new isotopes far from the line of stability by heavy-ion reactions is examined. Cross-sections for complete fusion reactions are given. It is shown that the projectile should be as heavy as possible. In order to produce transuranium elements with good yields, the bombarment of targets must also be done with very heavy ions, because the compound nucleus has to be produced as "cold" as possible. This can be achieved if the Q-value of the nuclear reaction is very negative. A brief account is given of the identification method for the reaction products. (auth) (UK)

17929 NUCLEAR CHEMISTRY WITH THE OAK RIDGE ISOCHRONOUS CYCLOTRON. Silva, R. J.; Hahn, R. L.; Mallory, M. L.; (and others) (Oak Ridge National Lab., Tenn.). pp 42-50 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

The α-decay at an energy of 7.335 ± 0.003 MeV was tentatively identified as a new californium isotope (^{241}Cf) having a half-life of 3.1 ± 1.2 min. The energy of the α-decay of ^{242}Cf was found to be 7.385 ± 0.004 MeV in agreement with a previous value obtained at Berkeley. A 7.351 ± 0.006 MeV α-peak that decays to the first excited state of ^{238}Cm was resolved. Reduction potential measurements of ^{256}Md were performed and the results indicate that the potential is less than +0.3 volts versus the normal hydrogen electrode. Preliminary experiments to produce element 104 gave results consistent with those obtained at Berkeley. (auth) (UK)

17930 GAMMA RAY SPECTROSCOPY IN NUCLEAR REACTIONS. Knipper, A. (CNRS, Strasbourg). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.19-23(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Experiments based on the observation of the gamma-ray emission from nuclear reactions yielding important nuclear spectroscopic information, are discussed. Spectacular progress was made on germanium detectors. The information obtained, which was independent of the models chosen, allowed very precise verification of the wave functions of the levels. The most interesting results are: the width of the levels or the absolute mean life, the relative widths or branching ratios, spectroscopic data and the mixing coefficients, found in general by the angular correlation method. (France)

17931 SCATTERING OF 156 MeV PROTONS ON TIN EVEN NUCLEI. Comparat, V. (Univ. Paris, Orsay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.83-4(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The inelastic scattering of 156 MeV protons on tin even nuclei was interpreted using the DWBA. The finite-range effects of the complete nucleon–nucleon interaction were taken into account. The calculations were improved. (France)

17932 PHOTONUCLEAR REACTIONS (γ,xn) IN SPHERICAL NUCLEI. Carlos, P. J.; Veyssiere, A.; Bergere, R.; Beil, H.; Lepretre, A. (CEN, Saclay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.114-15(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Structure was clearly observed in the partial $\sigma(\gamma,n)$ and total photoneutron cross sections σ_{total} (Eγ) for ^{208}Pb, ^{89}Y, Sr, and ^{93}Nb. The results were compared to the particle-hole calculations of the giant dipole states; good agreement was found with the theoretical predictions of the isobaric splitting of the giant dipole states. (auth) (France)

17933 ANALYSIS OF THE REACTIONS (^{3}He,d), (α,^{3}Hσ), (d,d') FOR A SYSTEMATIC STUDY OF In EVEN–ODD ISOTOPES. Conjeaud, M.; Harar, S.; Thuriere, E. (CEA, Saclay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.137-8(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The spectroscopic factors extracted from the analysis of the Cd(^{3}He,d) reactions give the occupation probability of the two proton-holes in the $1g_{9/2}$, $2p_{1/2}$, $2p_{3/2}$ orbitals in the Cd fundamental states. The (^{3}He,d), (d,^{3}He), (d,d') reactions leading to the same residual nucleus ^{115}In populated, up to 1.5 MeV excitation energy, three sorts of states which were essentially: spherical one proton hole states, deformed (1p-2h) and spherical due to the weak coupling of a proton hole to the 2^+ collective excitation of the core. (auth)

17934 PROBABILITIES OF M1 TRANSITIONS IN SOME ODD NUCLEI OF RARE EARTH ELEMENTS. Gerber, J.; Vivien, J. P.; Macher, A.; Dar, Y.; Armbruster, R. (CNRS, Strasbourg). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.150-1(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The mean lives of the first excited states in ^{181}Ta, ^{165}Ho and of the second state in ^{159}Tb were measured with the microwave method. The results show that the values of gK-gR are found to be in agreement with those from higher transitions in the ground state rotational bands of these nuclei. There is a possibility that the M1 transition from the first excited state in ^{159}Tb is not in agreement with a pure rotational picture. (auth) (France)

17935 HIGHER SPIN LEVELS FROM (α,2nγ) REACTIONS. Barneoud, D. (Univ., Grenoble, France); Foin, C.; Baudry, A.; (and others). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.152-3(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

By means of (α,2nγ) reactions on Tm and Lu targets the levels of ^{171}Lu and ^{177}Ta were excited. Assignments were made for the rotational bands. (auth) (France)

17936 EXPERIMENTAL EVIDENCE OF THE EFFECT OF THE DEFORMATION OF NUCLEI ON THEIR rms RADIUS. Cassagnou, Y. (CEA, Saclay, France); Foissel, P.; Lamehi-Rachti, M.; (and others). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.156-7(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The Coulomb energy differences ΔE_c for several heavy nuclei (from N = 82 to N = 126) were obtained by determining accurate analogue state resonance energies. The plot of the differences between all the experimental values of ΔE_c known in this region and the values calculated with the Anderson and Wong formula clearly shows the effect of deformation on ΔE_c; this effect can be accounted for by the increase of the r.m.s. radius for deformed nuclei. (auth) (France)

17937 STUDY OF THE ^{209}Bi(p,f) REACTION AT 30, 34, AND 40 MeV. Barjon, R.; Engelhardt, D.; Gravost, M.; Guerre-Chaley, B.; Le Prince, M. (Univ., Grenoble, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.213-14(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Fission fragment energies and angular distributions of fragments from fission of ^{210}Po* produced by the reaction ^{209}Bi(p,f) at proton beam energies of 30, 34, and 40 MeV were measured. The spectra show symmetrical mass distribution. (auth) (France)

17938 MECHANISM OF THE NUCLEAR REACTIONS INDUCED BY α PARTICLES ON HEAVY NUCLEI. Bimbot, R.; Le Beyec, Y. (Univ. Paris, Orsay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.215-16(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Cross sections for production of various isotopes of Po and Bi by (^{4}He,xn) and (^{4}He,pxn) reactions from ^{206}Pb and ^{208}Pb were measured between 60 and 150 MeV. From these the cross section for compound-nucleus formation was deduced. The existence of non-compound nucleus processes is demonstrated and various hypotheses are discussed. (auth) (France)

17939 STATISTICAL CALCULATIONS OF ALPHA PARTICLE DISTRIBUTIONS IN (α,α') REACTIONS INDUCED BY 54 MeV ALPHA PARTICLES. Demeyer, A.; Chery, R.; Chevarier, A.; (and others) (Univ., Lyon). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.225-6(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Energy and angular distributions were measured for (α,α') reactions on silver with 54 MeV alpha particles. Statistical calculations were performed with a preequilibrium component. (auth) (France)

17940 APPLICATION OF THE STATISTICAL MODEL TO THE STUDY OF (α,xn) EXCITATION FUNCTIONS OF Ho AND Tm. Demeyer, A.; Chery, R.; Chevarier, N.; (and others) (Univ., Lyon). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.227-8(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Cross sections of reactions (α,xn) induced by alpha particles on ^{169}Tm and ^{165}Ho were measured up to 150 MeV. Excitation functions were calculated in terms of statistical theory using a spin dependent level density parameter and the preequilibrium model of Griffin. (auth) (France)

17941 GAMMA-RAY DECAY SCHEMES FOR ^{142}Xe, ^{142}Cs, ^{142}Ba, AND ^{142}La. Larsen, Jon Thorsten. Ames, Iowa; Iowa State Univ. (1970). 142p. University Microfilms Order No. 70-18,888. Thesis.

Measurements are reported for gamma ray energies and intensities present in the decays of the four nuclei ^{142}Xe, ^{142}Cs, ^{142}Ba, and ^{142}La. These nuclei are all members of the isobaric decay chain beginning with ^{142}Xe, which was made available by use of an on-line isotope separator system developed for the study of gaseous fission products. Partial energy level schemes were constructed for ^{142}Cs, ^{142}Ba, ^{142}La, and ^{142}Ce with the aid of Ge(Li)-Ge(Li) coincidence data. Some spin-parity assignments were made for levels in ^{142}Ba and ^{142}Ce; comparative half-lives were calculated for the decays of ^{142}Ba and ^{142}La. An attempt is made to interpret some of the energy levels in the even-even ^{142}Ba and ^{142}Ce nuclei; these nuclei appear to exhibit vibrational-like excitations. (Diss. Abstr. Int., B)

17942 REACTION (d,^{3}He) ON EVEN-A TIN ISOTOPES. Weiffenbach, Conrad Venable. Ann Arbor, Mich.; Univ. of Michigan (1970). 127p. University Microfilms Order No. 70-21,812. Thesis.

The (d,^{3}He) reaction on the isotopes ^{116}Sn, ^{118}Sn, ^{120}Sn, ^{122}Sn, and ^{124}Sn was studied experimentally with a deuteron bombarding energy of 28.9 MeV. High-resolution spectra were recorded, and angular distributions for levels strongly excited in the odd-mass indium isotopes were recorded for scattering angles ranging from 5 to 60 degrees, using a magnetic spectrograph with nuclear emulsions and a positron-sensitive detector. Cross sections and Q-values for the levels excited by the reaction were measured. An analysis of the experimental results using distorted-wave calculations was carried out. The spectra of the odd indium isotopes are quite similar. The ground state and first and second excited states of each isotope have l = 4, l = 1, and l = 1 angular distributions, and are excited by pick-up of $1g_{9/2}$, $2p_{1/2}$, and $2p_{3/2}$ protons respectively. Levels excited by pick-up from the $1f_{7/2}$ single-particle level were not found. Levels having l = 2 angular distributions are weakly excited in each isotope at around 1.0 MeV; their interpretation is uncertain. A few levels having l = 4 and l = 1 angular distributions are excited in the range of 1.4 to 1.7 MeV of excitation in each isotope and are believed to indicate the mixing of proton hole and coupled hole-collective configurations in states of the odd indium nuclei. (Diss. Abstr. Int., B.)

17943 INVESTIGATION OF THE BETA DECAYS OF ^{115m}Cd, ^{115g}Cd, AND ^{140}La. Horgan, John Raymond Jr. Amherst, Mass.; Univ. of Massachusetts (1970). 137p. University Microfilms Order No. 70-23,035.

Thesis.

The beta decay of ^{115m}Cd (43 day) to the ground state of ^{115}In was investigated by measuring the beta ray longitudinal polarization while the beta decays of ^{115}Cd (2.3 day) and ^{140}La (40 hour) to some excited states in the respective daughter nuclei ^{115}In and ^{140}Ce were studied by means of beta-gamma directional correlation. (TSS) (Diss. Abstr. Int., B)

17944 GAMMA-GAMMA AND CONVERSION ELECTRON-GAMMA DIRECTIONAL CORRELATIONS IN ^{125}Te. Champion, James Robert. Morgantown, W. Va.; West Virginia Univ. (1970). 143p. University Microfilms Order No. 70-22,596. Thesis.

Gamma-gamma and conversion electron-gamma directional correlation measurements were made on several gamma cascades in ^{125}Te which follow the decay of 2.7 yr ^{125}Sb. The results are consistent with the spin assignments $\frac{1}{2}^+$, $\frac{3}{2}^+$, $\frac{11}{2}^-$, $\frac{9}{2}^-$, $\frac{5}{2}^+$, $\frac{5}{2}^-$, $\frac{7}{2}^+$, and $\frac{5}{2}^+$ to the ground state, 35, 145, 321, 463, 524, 642, and 670 keV levels. The multipolarity for the 428 keV gamma ray is M1 with E2 < 1%. The 635 keV gamma ray is M1 with E2 < 3%. The 320 keV gamma ray is E1 with M2 < 9% and the 202 keV gamma ray is M1 + E2 with E2 = 28 ± 2%. (Diss. Abstr. Int., B)

17945 A STUDY OF ISOBARIC ANALOGUE RESONANCES IN THE Yb ISOTOPES. Whineray, S.; Dietrich, F. S.; Stokstad, R. G. (Univ. of Copenhagen). Nucl. Phys.; A157: 529-51(1970).

Excitation functions were measured for ^{168,170,172,174,176}Yb(p,p) and isobaric analogue resonances observed. An extensive analysis was made of the ^{174}Yb(p,p) data and in this case spectroscopic factors were determined, which are in fair agreement with (d,p) data. Coulomb displacement energies were determined for five Lu–Yb isobaric pairs and the systematics of these and other data support the expected decrease in ΔE_c for deformed nuclei. The resonance data combined with a high resolution ^{174}Yb(d,p) experiment allow tentative identification of a rotational band based on the $\frac{1}{2}^+$[651] orbital in ^{175}Yb. The location of this orbital in four other Yb isotopes was deduced. (auth)

17946 TOTAL CROSS SECTIONS AND ISOMERIC CROSS-SECTION RATIOS FOR (n,2n) REACTIONS IN THE ENERGY REGION 12 TO 18 MeV. Bormann, M.; Bissem, H. H.; Magiera, E.; Warnemuende, R. (Univ., Hamburg). Nucl. Phys.; A157: 481-96(1970).

The activation method was used to measure excitation functions for total or isomeric (n,2n) cross sections in the energy region 12 to 18 MeV for ^{93}Nb, ^{96}Ru, ^{104}Ru, ^{103}Rh, ^{102}Pd, ^{110}Pd, ^{128}Te, ^{130}Te, ^{142}Nd, ^{192}Os, ^{191}Ir, and ^{198}Pt. Isomeric (n,2n) cross-section ratios were measured for ^{110}Pd, ^{128}Te, ^{130}Te, and ^{198}Pt in the whole energy region stated and were further obtained for ^{93}Nb and ^{103}Rh for two energies by combining experimental isomeric cross sections with special (n,2n) cross-section systematics. The measured total (n,2n) cross sections are discussed with respect to the dependence of this quantity on the neutron excess of the target nucleus. The results were compared with predictions from the statistical theory and special consideration given to the competition between γ and neutron emission. From the isomeric cross-section ratios spin cut-off parameters $\sigma(\hbar)$ were deduced according to the method of Vandenbosch and Huizenga. The same analysis was also applied to all isomeric (n,2n) cross-section ratios available from the literature. The resulting properties of $\sigma(\hbar)$ are compared with the theoretical predictions. (auth)

17947 A STUDY OF NUCLEAR LEVEL SPINS OF ^{142}Pr BY MEANS OF NUCLEAR ORIENTATION. Mellema, J.; Reddingius, E. R.; Postma, H. (Kamerlingh Onnes Lab., Leiden). Nucl. Phys.; A157: 577-83(1970).

Anisotropies of directional distributions of high- and low-energy gamma rays emitted after thermal neutron capture in oriented ^{141}Pr nuclei were measured. The nuclei were oriented in single crystals of $Pr_2Mg_3(NO_3)_{12} \cdot 24\ H_2O$. Conclusions concerning the spins of several excited states were drawn from the anisotropies. Definite spin values, 3 and 4, were obtained for the levels at 17.7 and 144.6 keV, respectively. (auth)

17948 DETERMINATION OF SPINS IN THE DECAY OF ^{219}Rn → ^{215}Po BY ALPHA–GAMMA LINEAR POLARIZATION MEASUREMENTS. Krien, K.; Canty, M. J.; Herzog, P. (Univ., Bonn). Nucl. Phys.; A157: 456-70(1970).

The $\alpha\gamma$ linear polarization correlation coefficients of the 271 keV and 401 keV γ transitions in the decay of ^{219}Rn were determined to be $B_2 = 0.029 \pm 0.011$, $B_4 = 0.0147 \pm 0.0042$; $B_2 = -0.093 \pm 0.0084$, $B_4 = 0.0130 \pm 0.0034$, respectively. The 130 keV γ–271 keV γ angular correlation has the coefficients: $A_2 = -0.060 \pm 0.041$, $A_4 = 0.003 \pm 0.073$. The E2/M1 mixing ratio $\delta^2 = 0.32 \pm {}^{0.07}_{0.05}$ of the 130 keV transition was derived from an L-subshell conversion coefficient measurement. The values $A_2 = -0.060 \pm 0.020$ and $A_4 = -0.157 \pm 0.020$ were measured for the α-271 keV γ angular correlation. Comparison with theoretical predictions taking mixing of α-waves into account leads to a spin assignment for the ground state of ^{219}Rn ($I_i = \frac{7}{2}$) and for the levels at 401, 271, and 0 keV in ^{215}Po [I = ($\frac{9}{2}$, $\frac{11}{2}$), $\frac{9}{2}$, $\frac{11}{2}$, respectively]. This is in contradiction to all previous assignments. An interpretation of the decay scheme is attempted. (auth)

17949 ANGULAR DISTRIBUTIONS OF FRAGMENTS IN THE FISSION OF URANIUM INDUCED BY NEUTRONS IN THE ENERGY RANGE 12 TO 18 MeV. Emma, V.; Lo Nigro, S.; Milone, C. (Univ., Catania, Italy). Nucl. Phys.; A157: 449-55(1970).

The angular distributions of fragments from neutron-induced fission of ^{238}U were measured by means of glass detectors in the range $12.2 \leq E_n \leq 18.2$ MeV. The behavior of the angular anisotropy in this energetic region, where (n,f), (n,n'f) and (n,2n'f) reactions are concurrent, was analyzed. (auth)

17950 GAMMA–GAMMA DIRECTIONAL CORRELATION AND HALF-LIFE MEASUREMENTS IN ^{128}Te. Bajaj, M. M.; Gupta, S. L.; Saha, N. K. (Univ. of Delhi). Proc. Indian Nat. Sci. Acad., Part A; 36: 176-90(May 1970).

The directional correlations of five gamma–gamma cascades in the decay of ^{128}Sb to the excited states of ^{128}Te were studied by the coincidence technique. The experimentally measured true directional correlation functions for the 206–427, 206–462, 171–427, 109–379, and 203–176 keV cascades are given. The results indicate spins of $\frac{1}{2}^+$, $\frac{3}{2}^+$, $\frac{11}{2}^-$, $\frac{1}{2}^+$, $\frac{7}{2}^-$, $\frac{5}{2}^+$, and $\frac{1}{2}^+$ (or $\frac{3}{2}^+$) for the ground state and 35-, 145-, 462-, 524-, 633-, and 668-keV levels, respectively. Half-life of the 35-keV first excited state of ^{128}Te was also measured using a fast time-to-amplitude converter and found to be (1.50 ± 0.08) nsec. Multipole characters of the 109-, 171-, 206-, and 379-keV radiations were investigated. The experimental partial lifetimes for the 35 and 206 keV radiations are estimated. (auth)

17951 CONVERSION PROBABILITY OF THE 35 keV TRANSITION IN ^{128}Te. Marelius, A.; Vaelivaara, K. G.; Awwad, Z.; (and others) (Uppsala Univ.). Phys. Scr.; 1: 91-2(1970).

The probability for K-conversion of the 35-keV M1 + E2 transition is determined from coincidences between Auger electrons and conversion electrons. The result is $\alpha_K = 0.804 \pm 0.010$. (auth) (Sweden)

Nuclear Theory

Refer also to abstracts 15964, 17427, 17589, and 17885.

17952 (BNL–50246) GROGI2: A NUCLEAR EVAPORATION COMPUTER CODE; DESCRIPTION AND USER'S MANUAL. Gilat, Jacob (Brookhaven National Lab., Upton, N. Y.). Jun 1970. 92p. Dep. NTIS.

GROGI2 is a spin dependent nuclear evaporation program designed to follow in detail the deexcitation of compound nuclei via neutron, proton, alpha, and photon emission channels. These four modes are permitted to compete with one another subject only to the phase space available to each. GROGI2 is written in FORTRAN IV for the CDC 6600 computer. (J.W.R.)

17953 (BNL-tr-368) NUCLEON–NUCLEON INTERACTION AND THE AVERAGE NUCLEAR FIELD. Babikov, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR)). · Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR–P4-4897. 29p. Dep. NTIS.

This item was previously abstracted from the original language and appeared in NSA as 24: 24609.

17954 (INR-P–1215) ON THE RESIDUAL INTERACTIONS OF PAIRING AND QUADRUPOLE-PAIRING TYPE. Stepien-Rudzka, W. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 12p. Dep. NTIS (U. S. Sales Only).

The residual two-body interaction is investigated. The new term is added to the standard pairing force, and its influence on the single-particle excitation spectra in heavy nuclei (transuranic region) is examined with special attention given to the behavior of so called "energy gap," a typical parameter in spectra of even–even nuclei. (auth)

17955 (JINR–E4-5456) GRAPHICAL METHOD FOR THE DETERMINATION OF ALL RESONANCE PARAMETERS IN NUCLEAR REACTIONS. Beregi, P. (Joint Inst. for Nuclear Research, Dubna (USSR), Lab. of Theoretical Physics). 1970. 14p. Dep. NTIS (U. S. Sales Only).

A method for the graphical determination of all parameters appearing in the generalized Breit–Wigner approximation for an isolated nuclear resonance is presented. Numerical examples are given for three different kinds of resonances of asymmetric form in the case of nonconstant background. (auth)

17956 (JINR–P4-5562) ELECTROMAGNETIC TRANSITIONS FROM THE COMPOUND STATES IN DEFORMED NUCLEI. Voronov, V. V.; Soloviev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The matrix elements for the Eλ and Mλ transitions from the high-lying states to the ground, two-quasiparticle, and one-phonon states of even deformed nuclei and to the one-quasiparticle and more compound states of odd deformed nuclei were obtained. The matrix elements of the Eλ and Mλ transitions are necessary for studying the structure of high-lying states. (auth)

17957 (LUNP–7010) CALCULATIONS OF MESONIC CONTRIBUTIONS TO THE (γ,n)-REACTION. Andersson, G.; Forkman, B.; Friberg, B. (Lund Univ. (Sweden). Dept. of Physics. Lund Inst. of Tech. (Sweden). Dept. of Nuclear Physics). Sep 1970. 44p. Dep. NTIS (U. S. Sales Only).

The contribution to the (γ,n)-reaction from the photo-pion production process was calculated for some light nuclei using a simple nuclear model. The result is in good agreement with experimental measurements. (auth) (Sweden)

17958 (N-70-38168) STATISTICAL THEORY OF INELASTIC NEUTRON ENERGY SPECTRA. Henderson, B. J.; Wuller, C. E. Jr. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). 16 Sep 1969. 29p. (NASA-TM-X-53913; MSFC-IN-SSL-N-68-14). NTIS.

A statistical theory of inelastic neutron energy spectra for intermediate excitation energies is developed. The final state of the residual nucleus may be either discrete or in the continuum. Calculated neutron energy distributions for aluminum are presented. (auth) (STAR)

17959 THE DEPENDENCE OF THE TRITON BINDING ENERGY ON THE HIGH-ENERGY PHASE SHIFT. Fiedeldey, H. (Univ. of South Africa, Pretoria). Nucl. Phys.; A156: 242-56 (1970).

An investigation of the dependence of the binding energy of the model triton on the high-energy part of the phase shift was made for an interaction consisting of a second-rank separable potential. For this investigation the previous exact solution of the inverse scattering problem for a second-rank separable potential was used. It is shown that for input phase shifts obtained from either a standard separable potential or a local potential with a repulsive core this high-energy dependence of the binding energy is rather small. However arbitrary modifications in the standard phase shift at high energies produce large effects in the binding energy, presumably resulting from the "unphysical" nature of such changes. It is also found that separable potentials reproducing the same two-body data as a local potential generally produce much higher triton binding energies than the local potential. The effect of the interaction between the high-energy on-shell phase shift and the off-shell behaviour of the potential on the triton binding energy is also discussed. (auth)

17960 MICROSCOPIC ANALYSIS FOR ELASTIC SCATTERING OF DEUTERONS AND ALPHA PARTICLES. Reeves III, Mark. Knoxville, Tenn.; Univ. of Tennessee (1970). 123p. University Microfilms Order No. 70-20,314.

Thesis.

A model is presented for the elastic scattering of deuterons and alpha particles. The target is assumed to have collective states which are excited by nonspherical interactions with each nucleon of the projectile. Nonlocal potentials are derived, and the elastic-channel Schroedinger equations containing these potentials are solved numerically for a ^{58}Ni target. Inelastic effects are included for both projectiles, but contributions from stripping and breakup appear only in the deuteron case. Discussion is presented to compare this work with that of other authors and to explore possible modifications which would bring the predictions of this model into closer agreement with experimental data. (Diss. Abstr. Int., B)

17961 OSCILLATIONS OF THE NUCLEAR DENSITY. Thorpe, M. A.; Thouless, D. J. (Univ. of Birmingham, Eng.). Nucl. Phys.; A156: 225-41 (1970).

The density of nucleons in a nucleus was calculated by a semiclassical method due to Kohn and Sham, which gives corrections to the Thomas-Fermi theory. The most important corrections are oscillations of wavelength π/k_F both near the surface and near the center of the nucleus. The form of these oscillations in the limit of a very large nucleus was calculated. The results were compared with exact calculations for the density of nucleons in the nuclear shell model, but only rough agreement with semiclassical results was found. The effects of various corrections to the simple shell model are considered. (auth)

17962 EMPIRICAL RELATION FOR TOTAL STOPPING POWER OF POSITONS AND ELECTRONS. Batra, R. K.; Sehgal, M. L. (Aligarh Muslim Univ., India). Nucl. Phys.; A156: 314-20 (1970).

A simple empirical relation for the total stopping power of positons and electrons of kinetic energies <500 keV was found. Using this empirical formula, the values of the stopping power of positons and electrons were calculated for Al, Cu, Ag, and Au. These values are in good agreement with the standard values and the maximum deviation being ≈4%. A simple criterion accounting for this deviation is pointed out. The procedure for the inclusion of multiple scattering effects on the penetration is also discussed. (auth)

17963 NILSSON'S HAMILTONIAN IN THE ASYMPTOTIC BASIS. Quentin, Philippe; Babinet, Regis (Service de la Metrologie et de la Physique Neutroniques Fondamentales, Gif-sur-Yvette, France). Nucl. Phys.; A156: 365-84 (1970).

The set of eigenvectors common to the axially symmetrical deformed harmonic oscillator and to the third component of angular momentum, was used as a basis of representation (asymptotic basis). In this basis, the matrix elements of Nilsson's Hamiltonian were calculated by means of creation and destruction operators. A rather simple calculation gives, after a diagonalization, level diagrams as a function of deformation. The influence of various corrective terms, used instead of l^2 and $l \cdot s$ (particularly l_T Nilsson's term) is discussed. Within the framework of these approaches and in order to test them, total energy was calculated as a function of deformation for some nuclei. Such a more precise calculation allows also a study of pseudocrossings of levels associated with $\Delta N = \pm 2$. (auth)

17964 THEORY OF DEUTERON BREAKUP IN NUCLEAR AND COULOMB FIELDS. Rybicki, Frank John. Pittsburgh; Univ. of Pittsburgh (1970). 128p. University Microfilms Order No. 70-18,365.

Thesis.

A theory of deuteron breakup including nuclear and Coulomb interactions is developed in the spirit of direct reaction theories which use the distorted wave Born approximation; the theory was suggested by R. C. Johnson. The model for the breakup can be thought of as inelastic scattering in which the bound deuteron is excited into an unbound state. The interaction responsible for this excitation is the sum of the neutron-nucleus and the proton-nucleus optical model potentials. The final state wave function is a product of a deuteron optical model wave function and of an unbound deuteron wave function. The theory is compared to experimental breakup cross sections of 12 and 17 MeV deuterons on gold and of 12 MeV deuterons on rhodium. The theory is in disagreement with experiment. For the experiments studied, this disagreement is attributed to the treatment of the proton-nucleus Coulomb interaction in the final state. The methods developed for handling the long range tail of the Coulomb interaction are directly applicable to distorted wave Born approximation calculations of inelastic scattering in which Coulomb excitation cannot be neglected. (Diss. Abstr. Int., B)

17965 METHOD OF CALCULATING ROTATIONAL STATES USING HARTREE-FOCK-SKYRME SELF-CONSISTENCY. Ng, W. Y. (Univ. of Toronto); Trainor, L. E. H.; Wong, S. K. M. Phys. Lett.; 33B: 545-6(21 Dec 1970).

A method of treating rotational states involving a combined Hartree-Fock-Skyrme self-consistent procedure is investigated using the quadrupole-quadrupole forces model in the 2s-1d shell. (auth)

17966 PROBABILISTIC INTERPRETATION OF EXPANSION COEFFICIENTS IN THE NON-RELATIVISTIC QUANTUM THEORY OF RESONANT STATES. Berggren, T. (Lund Inst. of Tech., Sweden). Phys. Lett.; 33B: 547-9(21 Dec 1970).

It is suggested that "complex probabilities" appearing in eigenfunction expansions involving resonant states can be interpreted in terms of two real probabilities. This is shown to be consistent with identification ambiguities due to the finite lifetime of such states. (auth)

17967 COMPLETELY MICROSCOPIC DESCRIPTION OF THE 2p-1f SHELL NUCLEI. Boiti, A.; Gmitro, M.; Rimini, A.; Weber, T. (Univ., Trieste, Italy). Phys. Lett.; 33B: 553-5(21 Dec 1970).

An effective Hamiltonian for shell-model calculations of the nuclei around ^{56}Ni in the complete 2p-1f shell is derived. It is calculated in a fully microscopic way from the Tabakin potential, using the lowest order perturbation theory and including the processes due to the off-diagonal elements of the one-body part of the bare Hamiltonian. The effective Hamiltonian is used in a 2p-2h calculation of ^{56}Ni. (auth)

17968 ENERGY LEVELS ARISING FROM RESONANT TWO-BODY FORCES IN A THREE-BODY SYSTEM. Efimov, V. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett.; 33B: 563-4(21 Dec 1970).

Resonant two-body forces are shown to give rise to a series of levels in three-particle systems. The number of such levels may be very large. The possibility of the existence of such levels in systems of three α-particles (^{12}C nucleus) and three nucleons (^{3}H) is discussed. (auth)

17969 T = 0 AND T = 1 PAIRING IN LIGHT NUCLEI. Goodman, Alan Leonard. Berkeley, Calif.; Univ. of California (1969). 335p. University Microfilms Order No. 70-17,567.

Thesis.

A generalized quasi-particle transformation is presented which includes n-n, p-p, and n-p (T = 0 and T = 1) pairing correlations. The quasi-particle coordinates are required to be complex. The resulting gap equations for N = Z even-even nuclei are solved for the nuclei in the sd shell. To permit interaction between the Hartree-Fock (HF) and pair potentials, the Hartree-Fock-Bogoliubov (HFB) equations, including both T = 0 and T = 1 pairing, are also solved for these nuclei. Although T = 1 pairing

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correlations are not significant, T = 0 pairing correlations play a very important role, rectifying many of the failures of the HF theory in this region. Evaluation of various approximations to HFB is facilitated by deriving the canonical form of the density matrix and the pairing tensor for generalized isospin-pairing. The general quasi-particle transformation is equivalent to the product of three transformations: an isospin-conserving rotation in particle space (canonical basis), an isospin-generalized "special" quasi-particle transformation, a rotation in quasi-particle space. The canonical basis often bears no resemblance to the corresponding HF basis. The third transformation may not be approximated by the unit transformation, nor is the pair potential diagonal in the canonical basis. The BCS approximation of neglecting elements of the pair potential connecting different spatial orbitals is therefore unjustified. Iterating between the HF and the BCS equations in an attempt to permit both degrees of freedom to interact with one another is an even worse approximation to HFB than merely solving the BCS equations with the trivial HF basis. The HFB equations are derived by a variational principle. The self-consistent symmetries of the HFB solutions are discussed. Usage of the same effective interaction in both the HF and the pair potential is justified. (TSS) (Diss. Abstr. Int., B)

17970 NONPERTURBATIVE STUDY OF THE ISOBARIC MULTIPLET MASS EQUATION. Lacy, Curtis Elmo. Seattle; Univ. of Washington (1970). 167p. University Microfilms Order No. 70-19,635.

Thesis.

An investigation of the isobaric-multiplet mass equation (IMME) is carried out, in which the Coulomb perturbation is not treated by perturbation theory but is included exactly in the model Hamiltonian. An estimate is made of the first non-perturbative correction to the first-order IMME, proportional to T_z^3, and is compared with results from recent experiments. Two complementary models are developed. The first is a simple one-particle model which uses a realistic average central nuclear potential, but does not include antisymmetrization effects or residual interactions between valence nucleons. The main result obtained from this simple model is that the coefficient of the T_z^3 term is much smaller than has been expected from earlier order-of-magnitude estimates. The second model consists of a closed, inert core plus valence nucleons interacting with each other via two-body potentials. The valence-nucleon wave function is fully antisymmetrized. Harmonic-oscillator wave functions are used to facilitate the calculation of the two-body matrix elements for the residual interaction. The results from this model for nuclei of mass number A = 19 confirm the conclusion from the simple model that the coefficient of the T_z^3 term is small. Charge-dependent effects other than the Coulomb interaction are also studied. Terms of order $Z\alpha^2$ or larger are estimated; and terms of order α^2, neglected. It is found that the introduction of charge dependence (while keeping charge symmetry) in nuclear forces noticeably influences the IMME, but not so much as to change the central conclusion regarding the T_z^3 term. Other charge-dependent charge effects do not materially affect the IMME. It is shown that, in second-order perturbation theory, only the valence nucleons contribute to deviations from the quadratic first-order IMME. (TSS) (Diss. Abstr. Int., B)

17971 A COUPLED CHANNEL SCHROEDINGER EQUATION MODEL FOR FOUR NUCLEONS. Hale, G. M.; Umerjee, R. K. (Texas A and M Univ., College Station). Nucl. Phys.; A156: 570-92(1970).

A charge-independent model was developed for describing the two-body scattering processes possible in a system of four nucleons. When the model wave function and Hamiltonian are inserted in Schrödinger's equation, coupled differential equations result for the radial functions associated with the two-body channels of the system. A matrix of effective potentials is specified to solve these equations, and to obtain scattering observables for all the two-body processes in the four-nucleon system. (auth)

17972 NUCLEAR CLUSTER MOTION IN A DEFORMED HARMONIC OSCILLATOR POTENTIAL. Chang, F. C. (St. John's Univ., Jamaica, N. Y.). Nucl. Phys.; A156: 641-6(1970).

A general formula for the Talmi coefficients for two particles of unequal masses in an axially symmetric oscillator potential was derived. As an example, a wave function describing an alpha cluster in such a deformed potential is expanded, by means of these coefficients, in terms of single-particle oscillator wave functions. (auth)

17973 EXTRACTION OF SPECTROSCOPIC FACTORS FROM ISOBARIC ANALOGUE RESONANCES WITH STRONG INELASTIC BACKGROUND. Ginocchio, J. N.; Schucan, T. H. (Yale Univ., New Haven). Nucl. Phys.; A156: 629-40(1970).

In cases for which the inelastic background is small, the proton partial width for populating an isobaric analog state by scattering from a particular state of the target (channel) is proportional to the spectroscopic factor for stripping a neutron in the same state of the target to form the parent of the analog state. The constant of proportionality is the single-particle width. It is shown that for cases for which the inelastic background is large, then the proton partial width for populating the analog state is a linear combination of these spectroscopic factors for populating the analog state through these strongly coupled channels. The matrix that couples the channels was obtained by solving a coupled-channels program for the proton wave function. (auth)

17974 ABSOLUTE NORMALIZATION OF TRANSFER AMPLITUDES IN THE DWBA AND VERTEX FUNCTIONS FOR LIGHT NUCLEI. Kok, L. P.; Rinat, A. S. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A156: 593-9(1970).

A critical comparison was made of various determinations of the normalization constant for transfer amplitudes in the zero-range DWBA, when they employ wave functions. The results for (^{3}He,d) reactions are compared with an independent calculation based on dispersion relations for partial wave neutron–deuteron scattering amplitudes. A recently proposed uniform parameterization of vertex functions for (d,p), (^{3}He,d) and (α,^{3}He) reactions is discussed. (auth)

17975 EXCHANGE AND OVERLAP CORRECTIONS IN ELECTRON CAPTURE. Vatai, E. (Inst. of Nuclear Research, Debrecen, Hungary). Nucl. Phys.; A156: 541-52(1970).

The approximations made in calculations of the exchange and overlap correction coefficients were investigated. The one-electron wave functions of the final state cannot be replaced by those of the unexcited daughter atom, and the overlap of all inner s, p and d electrons is to be taken into consideration. The new approximation gives a better agreement with the experimental K/β^+, L/K and M/L capture ratios than the old approximation. (auth)

17976 APPLICATION OF THE PROJECTION METHODS TO THE STUDY OF THE STRETCH SCHEME. Raynal, J. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris); 31: 135-48(Feb-Mar 1970). (In French).

The stretch scheme introduced by Danos and Gillet for a system of neutrons and protons gives a rotational spectrum for almost any residual interaction. Simple formulas are obtained for the energies if antisymmetrization is not taken completely into account. The projection method with finite rotations enables one to obtain the spectrum with complete antisymmetrization. The results are the same as the approximate ones when the shell is large and less than half-filled. This method can also be used to compare energies for states with positive and negative intrinsic deformations. Using the method of infinitesimal rotation operators, one considers systems where an excess of neutrons is coupled in the stretch scheme or into pairs of zero angular momentum. The ground state energies are mainly a function of the number of "quartets" (two neutrons and two protons coupled in the stretch scheme). (France)

17977 RESONANT APPROXIMATION FOR SINGLE-PARTICLE RESONANCES IN THE RENORMALIZED RPA PROBLEM. Weigel, M. (Univ. of California, Berkeley). Z. Naturforsch.; 25a: 1562-7(Nov 1970).

An approximate version of the renormalized RPA treatment for scattering of nucleons on a hole nucleus is given, in which the shape resonances are treated according to a method of Balashov et al. In order to make the results more transparent the additional influence of the nonresonant part of the single-particle continuum is taken into account with the help of a separable particle-hole force. (auth)

17978 NATURE OF THE HARTREE–FOCK ENERGY GAP. Parikh, J. C. (Univ. of Rochester, N. Y.); Castel, B.; Stewart, K. W. C.; Lande, A. Nucl. Phys.; A156: 501-10(1970).

The Hartree–Fock energy gap was examined for deformed nuclei in the sd shell using a Rosenfeld interaction. It is shown that the results of self-consistent calculations are in good agreement with those obtained from a generalized Nilsson potential, implying that the energy gap may be ascribed to deformation. A many-particle description of the gap using the SU_3 scheme shows that the space symmetry effect is dominant and is responsible for the gap. It is suggested that this apparent contradiction arises as a consequence of working in a small space. (auth)

17979 THE TRANSITION SPHERICAL → DEFORMED FOR COLLECTIVE K = 0 STATES IN EVEN NUCLEI. Holzwarth, G. (Technische Hochschule, Munich). Nucl. Phys.; A156: 511-28 (1970).

A variational formulation, which takes into account both anharmonicities in the boson expansion of the Hamiltonian and angular momentum projection leads to a system of equations that describes the whole transition region of even nuclei. In terms of a model Hamiltonian the phase transition spherical → deformed is discussed in the frame of K = 0 states. For strong deformations the possibility of expansions in terms of deformed bosons is indicated. (auth)

17980 A WEAK COUPLING CALCULATION FOR THE POSITIVE PARITY STATES OF THE A = 15 NUCLEI. Lie, S.; Engeland, T.; Dahll, G. (Univ. of Oslo, Blindern, Norway). Nucl. Phys.; A156: 449-64(1970).

A calculation of the positive parity states for A = 15 was performed in a weak coupling approach. Based on particles in the sd shell and holes in the p-shell the final eigenstates are found to be admixtures of 1p−2h T_h = 0, 1p−2h T_h = 1 and 3p−4h configurations. Good agreement is obtained with the experimental energy levels below 10 MeV. In ^{15}O an additional $5/2^+$ state is predicted at 8 to 9 MeV excitation energy. The wave functions are compared with the structure information obtained from direct reactions. The electromagnetic decay properties are investigated and in most cases we find good agreement with experiment. (auth)

17981 SHELL MODEL OF THE DIPOLE STATES OF MASS-15 NUCLEI. Fraser, R. F.; Garnsworthy, R. K.; Spicer, B. M. (Univ. of Melbourne). Nucl. Phys.; A156: 489-500(1970).

Energies and absorption strengths were calculated for the dipole states of mass-15 nuclei within the space of 1h and 2p−1h states. Calculations were made for both a zero-range residual force with Soper mixture, as well as for a Gaussian force with spin and isospin exchange — the Gillet force. Comparisons of the results are made with experiments on the $^{15}N(\gamma,p_0)^{14}C$ and $^{14}N(p,\gamma_0)^{15}O$ reactions. (auth)

17982 INVESTIGATION OF THE EFFECTIVE INTERACTION BY MEANS OF A MODIFIED SHELL MODEL. Mueller, Dieter (Technische Univ., Hanover). Z. Phys.; 241: 466-72(1971).

The effective interaction U for a shell model with hamiltonian H_m is investigated by means of a "mixed" model with hamiltonian $\tilde{H}_m$. For this model the Born−v. Neumann expansion of the effective interaction $\tilde{U}$ reduces to its first two terms. Within the finite dimensional function space M_n used in the shell model calculation, the operators U and $\tilde{U}$ are exactly equivalent. This is used to show that an energy independent approximation for U, if it is possible at all, is necessarily equal to the residual interaction, i.e. to the difference between nucleon−nucleon interaction and shell model interaction. (auth)

17983 GAMMA TRANSITIONS IN THE THEORY OF FINITE FERMI SYSTEMS. Nicolai, Albert (Justus Liebig-Univ., Giessen, Ger.). Z. Phys.; 241: 423-34(1971). (In German).

The transition probability of the isometric M4-transitions $1g_{9/2} - 2p_{1/2}$, $1h_{11/2} - 2d_{3/2}$ and $1i_{13/2} - 2f_{5/2}$ in near magic nuclei is calculated on the basis of the theory of finite Fermi systems. It is shown that the constant g_0 for the spin−spin interaction of quasiparticles depends strongly on the special kind of representation for the single particle states. Using oscillator functions the value g_0 = 3.3 has to be taken, in order to get hindrance factors, which are approximately equal to one, whereas in the case of square well functions the constant g_0 = 1.4 is necessary, in order to get agreement with the experimental transition probabilities. (auth)

17984 OPTICAL POTENTIAL OF THE DEUTERON (^3H,^3He) AND THE TWO (THREE) NUCLEON VIBRATION COUPLING. Schuck, P. (Technische Univ., Munich). Z. Phys.; 241: 395-409(1971).

We present a closed expression for the exact deuteron (^3He, ^3He) optical potential in terms of higher point Green functions. This form is well suited to study its energy dependence. Intermediate resonances due to two (three) particle phonon coupling are suggested and the coupling constants are identified with the Migdal parameters. (auth)

17985 GENERALIZED TRANSLATION OPERATORS AND THE CONSTRUCTION OF POTENTIALS AT FIXED ENERGY. Coudray, Christiane (Institut de Physique Nucleaire, Orsay, France); Coz, Marcel. Ann. Phys. (N. Y.); 61: 488-529(Dec 1970).

Inverse problems either at fixed angular momentum or at fixed energy are usually solved by applying generalized translation operators (G.T.O.). It follows that most of the inverse problems are solvable when a suitable G.T.O. or a variant of it exists. When the energy E is kept fixed, such operators exist for zero-spin particle scattering by a nucleus; they exist also in the relativistic case of the Dirac equation. When spin−orbit forces are included in nucleon−nucleus scattering, some variant of them can be constructed. In the scattering of a zero-spin particle Newton's method is followed and extended to incorporate complex and Coulomb phase shifts. In both instances the existence of transparent potentials is found. (auth)

17986 PROPERTIES OF THE RPA THEORY OF NUCLEAR SCATTERING. II. PARTIAL WIDTHS AND TRANSITION RATES. Dover, Carl B.; Hahne, F. J. W. (Univ., Heidelberg). Nucl. Phys.; A150: 257-68(1970).

The influence of ground state correlations on partial widths for nucleon or γ emission from resonant states was studied within the framework of the random phase approximation (RPA), using a separable interaction. Three main points are emphasized: comparison of RPA with Tamm−Dancoff approximation (TDA), the influence of the continuum on the results for γ transition rates calculated using only the bound configurations generated by a finite shell-model potential, and the effects of the direct continuum−continuum coupling on particle escape widths. (auth)

17987 OPTICAL POTENTIAL FOR COMPOSITE PARTICLES. Samaddar, S. K. (Saha Inst. of Nuclear Physics, Calcutta); Satpathy, R. K.; Mukherjee, Suprokash. Nucl. Phys.; A150: 655-72(1970).

Optical potentials for the elastic scattering of deuterons, ^3He, and tritons were calculated in terms of the optical potentials of neutrons and protons forming the projectile. The angular distributions for the elastic scattering of these particles from various targets were calculated and compared with experimental results. (auth)

17988 CHARGE DEPENDENCE OF ONE-BOSON EXCHANGE POTENTIALS. Yalcin, C.; Yap, C. T. (Middle East Technical Univ., Ankara). Nucl. Phys.; A153: 424-32(1970).

The Fermi nuclear matrix elements M_F for the $\Delta J = 0$, $\Delta T = \pm 1$ β-decays of ^{41}Ar, ^{44}Sc, and ^{52}Mn are calculated theoretically in the jj-coupling shell model using in addition to the usual Coulomb potential one-boson exchange potentials with the mass splitting of the ρ-meson, $\delta\rho = \rho^{\pm} - \rho^0$, as a variable parameter. These results are compared with those obtained by using the Blin-Stoyle−Le Tourneux charge-dependent potential which contains parameters p and r that measure the deviation of nuclear forces from exact charge symmetry and q and s that measure the deviation of nuclear forces from exact charge independence. Comparison yields $3r - p \approx 0.1\%$ whereas $3s - q$ is dependent on $\delta\rho$. Using the well-attested relation of $3s - q \approx 1\%$, we obtain $\delta\rho$ in the range, $-1\frac{1}{2}$ to -5 MeV, which is consistent with experimental values to date. With $\delta\rho = -3$ MeV it is found that the theoretical values of M_F are consistent with the experimental ones for the decays under consideration. (auth)

17989 INVESTIGATION OF THE STATES OF 2s-1d SHELL NUCLEI BASED ON THE FOUR-PARTICLE-FOUR-HOLE STATE IN ^{16}O. Tewari, S. N.; Struble, G. L. (Univ. of California, Berkeley). Phys. Rev., C; 1: 1156-66(Apr 1970).

The four-particle−four-hole state in ^{16}O and the corresponding states in the even−even, N = Z nuclei of the 2s−1d shell are investigated in the framework of the Hartree−Fock approximation. Detailed calculations are performed in each case to determine the most stable Hartree−Fock solution. By assuming a simple model, the excitation energies of the band heads are calculated showing that ^{24}Mg is the last nucleus where a state analogous to the four-particle−four-hole state in ^{16}O might be observed. Energy levels are calculated in ^{16}O, ^{20}Ne, and ^{24}Mg using a basis of good angular-momentum states. A comparison between the predicted and the observed energy spectrum is shown In ^{16}O, calculations are performed both with phenomenological and realistic interactions and the results are compared. The accuracy of the projected angular-momentum states from the twelve-particle−four-hole solution in ^{24}Mg is estimated and shows that the projected states in this case are close to the eigenstates. It is demonstrated that one of two 0^+ states observed around 7 MeV in ^{20}Ne is an eight-particle−four-hole state. (auth)

17990 MATRIX ELEMENTS FOR RADIATIVE TRI-NUCLEON REACTIONS. Davis, R. (Dept. of Theoretical Physics, Oxford). Nucl. Phys.; A154: 113-26(1970).

Matrix elements for photodisintegration and direct-capture reactions are simplified by means of group theory, new coordinate systems and other means to yield general and relatively simple forms for the matrix elements in angular, spin, and isospin variables and to simplify the remaining radial integrations. The overall problem is thus brought to a form involving finite sums which are multitudinous, but which can readily be performed mechanically. The conversion of bound states to the new formalism and the expansion of continuum states and of the radiative Hamiltonian in it are described. (auth)

XUM

17991 COMPLETE ANGULAR MOMENTUM ANALYSIS OF FADDE'EV–LOVELACE EQUATIONS BASED ON NON-CENTRAL PAIR FORCES. Stingl, M. (Weizmann Inst. of Science, Rehovot, Israel. Technische Hochschule, Munich); Rinat, A. S. Nucl. Phys.; A154: 613-25(1970).

Assuming separable, non-central nucleon–nucleon forces a complete angular momentum analysis of the Fadde'ev–Lovelace equations is presented in closed form. Partial wave amplitudes corresponding to exchange graphs for any spin are presented in both channel spin and helicity representations. These amplitudes form the input for the Fadde'ev–Lovelace equations. (auth)

17992 PARITY-MIXED HARTREE–FOCK SOLUTIONS IN THE 2s-1d SHELL. Giraud, B. (CEN de Saclay, Gif-sur-Yvette, France); Sauer, P. U. Nucl. Phys.; A154: 587-601(1970).

Hartree–Fock calculations were carried out for an excited state of ^{16}O, for ^{19}F, and for the N = Z, even nuclei of the 2s–1d shell. The trial determinants consist of an inert ^4He core and a cloud of orbitals. Parity mixture is allowed by expanding each orbital of the cloud in orbitals of both the 1p and the 2s–1d shells. The Hamiltonian contains a Gaussian or Yukawa force with a Rosenfeld exchange mixture, and phenomenological single-particle energies. Parity-mixed Hartree–Fock solutions were found for ^{16}O, ^{19}F, ^{20}Ne, ^{24}Mg, and ^{28}Si. States of pure parity were projected out of them. Their increase in binding energy with respect to the traditional, parity-pure Hartree–Fock solutions ranged from 0.4 to 4 MeV. However, this effect seemed to result largely from the lack of translation invariance induced by the use of phenomenological single-particle energies. The pear-shaped solutions exhibit a significant dipole moment and c.m. excitation. An attempt towards reducing this c.m. drifting by means of an external constraint fails to yield spuriosity-free solutions that retain some parity admixture. (auth)

17993 MODEL OF s-WAVE POTENTIALS WITH A HARD CORE. Hal'pern, E. S.; Lyakhovitskii, V. N.; Narodetskii, I. M.; Simonov, Yu. A.; Ter-Martirosyan, K. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 12: 287-92(Aug 1970). (In Russian).

Parameters are given for a set of static NN potentials having a form that allows analytical solution. A parameter c is taken to be from –1 (the Hulthen potential) up to high positive values $c = 10^4$ (the Woods–Saxon potential). Parameters r_c, U_0, and b are found by means of the χ^2 method, providing the best fit for the singlet and triplet s phase shifts in the energy region from 0 up to 400 MeV. The χ^2 value is found to have no sharp dependence on the potential shape (the parameter c). (auth)

17994 ON THE INTERACTION INDUCED BY THE EXCHANGE OF NUCLEONS BETWEEN TWO IDENTICAL NUCLEAR CORES. von Oertzen, W. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys.; A148: 529-47 (1970).

A formula for the interaction energy of a nuclear system comprised of two nuclei A and B, with B having a large probability to be represented as B = (A + c), is derived. A general formula for the interaction via the exchange of a particle c between two identical cores has been obtained. The scattering of a nucleus B on a nucleus A under the influence of the exchange interaction is discussed. Calculations for the scattering of ^{12}C on ^{13}C and ^{16}O on ^{12}C have been performed and very good agreement with experimental data has been obtained. (auth)

17995 ONE-BOSON-EXCHANGE POTENTIALS IN PROTON–PROTON BREMSSTRAHLUNG. Schiffrer, Giuliano (Univ., Frankfurt am Main); Drechsel, Dieter. Nucl. Phys.; A148: 286-98(1970).

The behavior of various one-boson-exchange potentials off the energy shell (OES) was investigated and compared to results given by the hard-core Hamada–Johnston potential. The potentials considered include the regularized potentials of Green and Ueda, the Bryan–Scott, and the Reid soft-core potential. For these potentials analytical expressions of the quasi-phases were derived in Born approximation. Cross sections for the process of proton–proton bremsstrahlung were calculated using the various potential models, and are compared to the experimental data. At an energy of about 100 MeV the OES effects of the one-boson-exchange potentials are in striking agreement among each other and differ from the hard-core Hamada–Johnston potential. The present data are compatible with both the Reid soft-core and the Hamada–Johnston potentials, though there is still a minor discrepancy between theory and experiment. (auth)

17996 11-MeV PROTON INELASTIC SCATTERING FROM EVEN–EVEN MEDIUM-WEIGHT NUCLEI. Perey, C. M.; Silva, R. J.; Dickens, J. K.; Perey, F. G. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 2: 468-77(Aug 1970).

The analysis of inelastic scattering of 11-MeV protons from quadrupole and octupole collective levels of 14 even–even nuclei between ^{48}Ti and ^{76}Ge is reported. The distorted-wave Born approximation was used to calculate the cross sections using the collective-model generalization of the optical model for inelastic scattering. The analysis was performed using both real and complex form factors for the model. A satisfactory description of all the data is obtained when a contribution due to compound-nucleus decay for most of the octupole levels and a few of the quadrupole levels is included. (auth)

17997 COMMENTS ON COHERENCE AND MIGDAL–WATSON THEORY IN nd → nnp. Aitchison, I. J. R. (Dept. of Theoretical Physics, Oxford). Nucl. Phys.; A148: 457-64(1970).

It was re-emphasized that a few low-order rescattering terms give a good fit, and a simple understanding, of the high-energy peak in the recoil proton energy spectrum at fixed angle in nd → nnp; in particular, of the narrowing of the peak as compared with Migdal–Watson theory. These terms are then used to discuss the effects of coherence and "off-shell corrections" on the phase of the partial wave amplitude in the nn channel. It was concluded that the entire amplitude carries the nn phase, but that there is an important real factor in the amplitude, multiplying the Migdal–Watson term, which is associated with the coherent sum of the low-order rescattering terms, and which is responsible for the narrowing of the peak. (auth)

17998 VELOCITY-DEPENDENT NUCLEON–NUCLEON INTERACTION. Petris, L. (Univ. of Melbourne). Nucl. Phys.; A148: 583-92(1970).

A velocity-dependent interaction of the form previously investigated by Tabakin and Davies for singlet states, was determined to fit S-, P- and D-wave nucleon–nucleon phase shifts up to 320 MeV for both singlet and triplet states. The Lippmann–Schwinger equation was solved in momentum space for the S-states using the Weinberg quasi-Born approximation. A simultaneous fit to the phase shifts, scattering lengths, deuteron binding energy, and nuclear matter results with small second-order corrections, is obtained. The results of Hartree–Fock calculations for the closed-shell nuclei ^4He and ^{16}O are also given. (auth)

17999 EFFECT OF PARTICLE-NUMBER PROJECTION ON THE DETERMINATION OF THE GROUND STATE OF SUPERCONDUCTING NUCLEI. Rimini, A.; Weber, T. (Univ., Trieste, Italy). Phys. Rev., C; 2: 324-5(Jul 1970).

The pair-distribution coefficients of the ground state of even nickel and tin isotopes are determined using both the standard BCS state and its number-projected component. The comparison of the results shows that a consistent number-conserving determination of the coefficients is, in general, necessary in the framework of the so-called projected quasiparticle Tamm–Dancoff approximations. (auth)

18000 BARYON RESONANCES IN NUCLEI WITH APPLICATIONS TO THE TWO-NUCLEON SYSTEM. Arenhoevel, Hartmuth (Max-Planck Institut fuer Chemie, Mainz); Danos, Michael; Williams, H. Thomas. Nucl. Phys.; A162: 12-34(1971).

The nonrelativistic description of the nucleus is presented which allows the possibility of excited baryon resonances within the nucleus via collision of the nucleons with exchanged mesons. A perturbative treatment for the intrinsically excited configurations is justified, and lowest order results for the wave functions of the excited configurations are derived. Detailed formulas for the two-nucleon system are presented and numerical results are given to show the effect of the baryon resonances on the magnetic moment and threshold photodisintegration of the deuteron. (auth)

18001 NUCLEAR BETA DECAY. Behrens, H. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.); Buehring, W. Nucl. Phys.; A162: 111-44(1971).

New formulas for nuclear beta decay are derived by using a modified expansion of the electron radial wave functions. This expansion is obtained by means of the integral equations which correspond to the Dirac radial differential equations. As a consequence new types of form factor coefficients or nuclear matrix elements occur which depend on the shape of the nuclear charge distribution. The implications of the new formulas for the analysis of experiments are discussed. The sensitivity to the detailed shape of the charge distribution turns out to be weak usually, even in the case of non-unique forbidden transitions. An elementary treatment of the induced interactions leads in a simple way to the formulae which express the form factor coefficients in terms of coupling constants and nuclear matrix elements. Ex-

pressions are given for the single-particle values of all the nuclear matrix elements in terms of radial integrals. (auth)

18002 CHARGE-DEPENDENT RADIATIVE CORRECTIONS TO THE FERMI MATRIX ELEMENT FOR PURE FERMI β-DECAYS. Jaus, W. (Univ., Zurich). Nucl. Phys.; A162: 97-110(1971).

The charge-dependent radiative corrections of order $Z^2\alpha^2$ to the Fermi matrix element for pure Fermi β-decays is calculated neglecting the effect of excited nuclear states. The calculation treats the nucleus as an elementary particle and makes use partly of the technique of dispersion relations and partly of perturbation theory. The charge-dependent corrections are free from ultraviolet divergences and the electromagnetic form factor reduces the relevant dispersion and perturbation integrals to their low-energy limit. This fact enables the application of a low-energy theorem to determine the structure-dependent terms and an approximation method to estimate the two-photon contribution. The result is a correction to the Fermi matrix element of a few hundredths of a percent which is entirely negligible. (auth)

18003 ROTATIONAL LEVELS OF DEFORMED DOUBLY EVEN NUCLEI. Abraham, P. M.; Rost, F. (Univ. of Colorado, Boulder). Nucl. Phys.; A162: 173-92(1971).

A model of deformed doubly even nuclei is described in which the nucleus is assumed to be made up of a rotating core and an even number of valence nucleons. The intrinsic motion of the valence nucleons is assumed to be strongly coupled to the nuclear rotation so that the total Hamiltonian of the system may be obtained as consisting of three parts: the rotational Hamiltonian, the intrinsic Hamiltonian and the rotational-particle interaction. Since the rotational-particle interaction gives rise to coupling between rotational bands, the eigenfunctions of the total Hamiltonian are taken to be superpositions of the usual adiabatic wave functions. The intrinsic energies are calculated by using a deformed Hamiltonian with pairing interaction and by setting up a two-quasiparticle basis for the intrinsic states. The rotational energies are obtained by setting up the total energy matrix with the help of a few collective parameters and by diagonalizing it in a truncated space of the basis states. The results of the calculations including the high-spin members of the ground state rotational band indicate that the experimental levels are well reproduced. Generalized decoupling parameters are extracted and compared with model calculations. (auth)

18004 SINGLE-PARTICLE STATES IN A SPHEROIDAL HARMONIC OSCILLATOR POTENTIAL WITH A DEFORMED SPIN-ORBIT INTERACTION AND A HEXADECAPOLE DEFORMATION. Andersen, B. L. (Univ. of Copenhagen). Nucl. Phys.; A162: 208-24(1971).

Using an anisotropic basis, a Nilsson model Hamiltonian with a spin-orbit force of the Thomas form is diagonalized. This approach is compared with the usual method. Inclusion of a P_4 deformation is shown to be important for the $\Delta N = 2$ mixing, which is very sensitive to the sign of this deformation. This fact seems to favour a better understanding of this mixing, which is thoroughly discussed. (auth)

18005 THREE-BODY MODEL FOR THE STUDY OF RESONANCE PHENOMENA. Beregi, P.; Lovas, I. (Central Research Inst. for Physics, Budapest). Z. Phys.; 241: 410-22(1971).

A three-body model suitable for the investigation of compound, quasi-compound and potential resonances is presented. The exact solution of the model based on Faddeev's method is discussed. Numerical calculations are performed for negative total energy. (auth)

18006 GAMMA-RAY MIXING RATIOS IN MIRROR NUCLEI. Glaudemans, P. W. M.; Van Der Leun, C. (Rijksuniversiteit, Utrecht). Phys. Lett.; 34B: 41-2(18 Jan 1971).

A review of the E2/M1 mixing ratios of corresponding γ-ray transitions in sd-shell mirror nuclei shows that for the 20 pairs of mirror transitions for which the mixing ratios are known to differ significantly from zero (i) the mixing ratios have opposite sign, and (ii) the ratio of the absolute values is remarkably close to unity. (auth)

18007 NUCLEAR MASS DISTRIBUTIONS FROM THE ELASTIC SCATTERING OF LOW-ENERGY α-PARTICLES. Batty, C. J.; Friedman, E. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Lett.; 34B: 7-9(18 Jan 1971).

The microscopic model is applied to the elastic scattering of α particles from ^{204,206,208}Pb and ^{209}Bi below and near the Coulomb barrier. The analysis shows that the root-mean-square radii of the nuclear mass distributions do not exceed the values of the charge rms radii by more than 0.1 fm. (auth)

18008 DIAGRAMMATIC EXPANSIONS FOR ISOBARIC ANALOG STATES AND THE COULOMB DISPLACEMENT ENERGY. Wong, Chun Wa (Univ. of California, Los Angeles). Nucl. Phys.; A151: 323-30(1970).

Certain aspects of diagrammatic expansions for isobaric analog states are discussed. The effect of the charge-distortion potential of Auerbach, Kahana, and Weneser on the Coulomb displacement energy was estimated to be about 6% by relating it to the average isotope shift of the core charge distribution. (auth)

18009 LEVINSON'S THEOREM AND DISPERSION RELATIONS FOR THE COULOMB SCATTERING IN THE λ-PLANE. Lopez, C. A.; Massidda, V. (Univ. of Chile, Santiago de Chile). Nucl. Phys.; A149: 33-40(1970).

The following properties in the λ-plane, which were recently proved for Yukawa-like potentials, Levinson's theorem for the phase at r = 0 of the irregular (Jost) solution $f(\lambda, -k, r)$ and a dispersion relation for the same function, were extended to the Coulomb case. Explicit use was made of the known analytic expression of the Jost functions. (auth)

18010 INTERMEDIATE COUPLING IN THE N = 29 AND Z = 29 NUCLEI. Larner, D. (Univ. of Kansas, Lawrence). Phys. Rev., C; 2: 522-30(Aug 1970).

Levels were calculated for the N = 29 and Z = 29 nuclei, ^{51}Ti, ^{53}Cr, ^{55}Fe, ^{61,63,65}Cu. The model used is the intermediate-coupling model with quasivibrational core, as developed by True and Thankappan. A pattern search routine was used to fit the five parameters to the levels and stripping strengths. Except for the case of ^{53}Cr, levels and strengths were fitted fairly well. In particular, in ^{55}Fe the states at 1.917 and 2.051 MeV were identified as $\frac{3}{2}^-$ and $\frac{1}{2}^-$ states, respectively. B(E2) values for transitions to the ground state were calculated, and the comparison with data for ^{63}Cu and ^{65}Cu shows good agreement. However, there are no experimental B(E2) data available for the other nuclei. (auth)

18011 ON THE NORMALIZATION OF GAMOW FUNCTIONS. Gyarmati, B.; Vertse, T. (Inst. of Nuclear Research, Debrecen, Hungary). Nucl. Phys.; A160: 523-8(1971).

It is proved that the definitions of the norm given by Berggren and Romo are identical. Regularization by the method of Berggren (Nucl. Phys., A109: 265(1968)) with any convergence factor of the form $\exp(-\epsilon r^n)$ $[1 < n < \frac{1}{2}\pi/\text{arctg}(\gamma/\kappa)]$ leads to the same result. The existence of the norm is also established for the proton. The norm for neutrons is analytically given. (auth)

18012 EFFECT OF THE JASTROW CORRELATION FACTOR ON NUCLEAR CHARGE DISTRIBUTIONS. Ripka, G.; Gillespie, J. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Phys. Rev. Lett.; 25: 6124-5(7 Dec 1970).

It is shown that for nuclear charge distributions the dominant effect of the Jastrow correlation factor is to produce a new uncorrelated Slater determinant, which is calculated explicitly. This is related to the absence of the Brueckner–Pauli operator in the Jastrow correlation factor. (auth)

18013 RELATIONSHIP BETWEEN THE TRITON ENERGY AND THE NEUTRON–DEUTERON DOUBLET SCATTERING LENGTH. Brady, T.; Harms, E.; Laroze, L.; Levinger, J. S. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., C; 2: 59-63(Jul 1970).

Phillips found a linear relation between the triton energy E_t and the doublet n–d scattering length ^2a for a variety of separable tensor potentials. We have treated many more separable potentials, and also the Tabakin and Mongan rank-two separable potentials. The linear relation holds well for two-body potentials that fit the energies of the two-body triplet bound and singlet antibound states. (auth)

18014 CALCULATION OF NUCLEAR ROTATIONAL ENERGIES. Krumlinde, J. (Lund Inst. of Tech., Sweden). Nucl. Phys.; A160: 471-81(1971).

Rotational energies are calculated for nuclei in the deformed regions both at the ground state and at very high deformations. The single-particle Hamiltonian includes both quadrupole and hexadecapole deformations. (auth)

18015 CONFIRMATION OF STRONG SECOND ORDER PROCESSES IN (p,t) REACTIONS ON DEFORMED NUCLEI. Ascuitto, R. J. (Yale Univ., New Haven); Glendenning, N. K.; Soerensen, B. Phys. Lett.; 34B: 17-20(18 Jan 1971).

The (p,t) reaction on deformed nuclei has been computed with the inclusion of indirect transitions that go through intermediate rotational states. The indirect transitions are almost as large as the direct for the 2^+ state and their inclusion is essential to bring about agreement with the shape and magnitude of the differential cross section. (auth)

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18016 DIVERGENCE OF THE LIQUID DROP MODEL FROM MASS RELATIONS OF GARVEY ET AL. Sorensen, R. A. (Research Inst. for Physics, Stockholm). Phys. Lett.; 34B: 21-3(18 Jan 1971).

The Garvey et al. mass formula is found to diverge from the expected behavior of a liquid drop, and a correction is proposed and computed. (auth)

18017 SPECTROSCOPIC ANALYSIS OF STRIPPING INTO RESONANCES. Bunakov, V. E. (Ioffe Inst. of Physics and Tech., Leningrad); Gridnev, K. A.; Krasnov, L. V. Phys. Lett.; 34B: 27-30(18 Jan 1971).

The DWBA spectroscopic factor S is shown to retain its physical meaning in stripping to resonances. The validity of the relation between S and the resonance width is discussed. A DWBA analysis is carried out of (dp) reaction for a number of resonant states. (auth)

18018 EVALUATION OF UNKNOWN EXCITATION FUNCTIONS FOR (α,xn) AND (d,xn) REACTIONS. Muenzel, H.; Lange, J. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). pp 373-82 of Uses of Cyclotrons in Chemistry, Metallurgy, and Biology. /Amphlett, C. B. (ed.). London; Butterworth and Co. Ltd. (1970).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England. See CONF-690924.

In order to evaluate the best irradiation conditions for the cyclotron production of radionuclides the excitation function for the reaction has to be known. Unfortunately, excitation functions for (α,xn) (α,pxn), (d,xn), and (α,pxn) reactions are known only for a few target-projectile combinations. In most cases therefore, a rather arbitrary guess is made about optimal target thickness and projectile energy. Therefore the possibility of estimating unknown excitation functions by interpolation was investigated. It can be shown that the influence of the charge and mass number of the target nucleus on characteristic data such as position, height, and shape of the known excitation functions can be explained by qualitative theoretical arguments. (auth) (UK)

18019 CONFERENCE ON NUCLEAR REACTION MECHANISM, MARCH 16-18, 1970, GRENOBLE, FRANCE. J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.1-240(May-Jun 1970). (In French and English). (CONF-700313).

Separate abstracts were prepared for each of the 81 papers presented. (France)

For abstracts of individual papers see: 16744, 17362–17364, 17367, 17652, 17699–17706, 17739–17766, 17825–17839, 17930–17940, and 18020–18032.

18020 SELECTED TOPICS IN NUCLEAR PHYSICS AT 1 GeV. Kofoed-Hansen, O. (European Organization for Nuclear Research, Geneva). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.11-18(May-Jun 1970).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Some of the conditions for the interpretation of elastic and sum nuclear inelastic scattering of high energy particles on nuclei are reviewed. The possibility of investigating short and long-range nuclear correlations is treated to some extent and measurements are proposed for the determination of short range correlations, Pauli correlations, specific aspects of nuclear deformation and of possible differences between neutron and proton distributions. (auth) (France)

18021 PHENOMENA RELATED TO COMPOUND NUCLEI. Bloch, C. (CEA, Saclay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.24-34(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Problems related to the formation and the decomposition of compound nuclei are studied. The shell model and the idea of a hierarchy of nuclear states are used. Experimental results concerning the formation of a compound nucleus are given. Statistics are then introduced into the theory of nuclear reactions and certain fundamental questions studied. A review of recent studies on the highly deformed states of heavy nuclei is given. (France)

18022 PHOTONUCLEAR REACTIONS. Schuhl, C. (CEA, Saclay, France); Argan, P. J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.35-45(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The present state of research on photonuclear reactions with real photons is discussed. The following points are reviewed: giant resonances, photonuclear reactions at the highest energies (in the 300 MeV region), and the photodisintegration of ^{2}D, ^{3}He and ^{4}He. (France)

18023 MICROSCOPIC THEORY OF NUCLEAR REACTIONS AND OPTICAL POTENTIAL. Vinh Mau, N. (Univ. Paris, Orsay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.52-7 (May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Scattering in a system consisting of a simple particle and a nucleus was studied. The non-antisymmetrized Feshbach approximation was used. A microscopic derivation exactly antisymmetrized to the optical potential was then sought. At the expense of introducing a certain number of approximations, the imaginary part of the optical potential in the scattering of 14 to 60 MeV nucleons by ^{40}Ca was calculated. Optical potentials were compared with non-local phenomenological potentials. (France)

18024 ELASTIC, INELASTIC, AND QUASI-ELASTIC SCATTERING. Marty, N. (Univ. Paris, Orsay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.58-64(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

A review is presented on all the recent experiments made on elastic, inelastic, and quasi-elastic scattering. Only experiments made at energies producing direct interaction processes are considered. (France)

18025 DIRECT INTERACTION TRANSFER REACTIONS. Faraggi, H. (CEA, Saclay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.65-78(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Direct transfer reactions in the framework of the D.W.B.A. are studied. The limits to the use of this approximation and the possible improvements made by considering the effect of mechanisms other than direct transfer are considered. The usefulness of the selective character of transfer reactions in the transfer of several nucleons induced by a heavy ion beam is emphasized. (France)

18026 EFFECTS OF THE NUCLEON-NUCLEON $\vec{L}\cdot\vec{S}$ INTERACTION ON THE ASYMMETRY OF PROTON INELASTIC SCATTERING. Raynal, J. (CEN, Saclay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.92-3(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The nucleon-nucleon $\vec{L}\cdot\vec{S}$ interaction exhibits the same features in a microscopic description that the deformed $\vec{L}\cdot\vec{S}$ coupling introduced by Blair and Sherif exhibits in the macroscopic description. In the zero-range limit, this interaction is purely T = 1 and is more important for nuclei with open shell for protons (^{90}Zr) than for nuclei with open shell for neutrons (^{62}Ni). (auth) (France)

18027 NON-LOCAL FORCES AND PHOTONUCLEAR REACTIONS IN HEAVY NUCLEI. Hammann, T. (Univ. of Laval, Quebec. Institut d'Etudes Nucleaires, Algiers). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.116-17(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The increasing of the cross section of the electric dipole transition due to the non-locality of the nuclear forces was computed in the plane-wave approximation for two realistic potentials, both non-local and separable. It appeared that a strong non-locality was necessary for the correct interpretation of the experimental photonuclear reaction data. (auth) (France)

18028 REACTION MECHANISM AND DIRECT INTERACTION FEYNMAN DIAGRAMS. Nalda, J. (Univ., Valladolid, Spain). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.123-4(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

Different mechanisms of reactions are explained through the theory of direct interaction accordingly with the associated diagrams. That may be very important for the determination of possible cluster structures of the nucleus. Calculations of the (d,α) and (n,x) reactions on light nuclei are presented. (auth) (France)

18029 WIDTHS OF ANALOG STATES. Cassagnou, Y.; Foissel, P.; Lamehi-Rachti, M.; (and others) (CEA, Saclay, France). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.131-2 (May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

A systematic study of the observed total widths of isobaric analog resonances is presented together with the behavior of the spreading width from calcium to lead. (auth) (France)

18030 STUDY OF THE FINITE RANGE INTERACTION IN THE TWO-NUCLEON TRANSFER REACTIONS. Joseph, J.; Fayard, C.; Lamot, G. H.; El Baz, E. (Univ., Lyon). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.170-1(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The two nucleon transfer reaction was studied in the frame of DWBA method, with a finite range interaction. It appeared that this effect is quite important in the evaluation of spectroscopic factors. (auth) (France)

18031 TARGET EXCITATION BY STRIPPING BELOW THE COULOMB BARRIER IN REACTIONS BETWEEN HEAVY IONS. Nakamura, Kosuke (Univ., Brussels). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.180-1(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

The analytic formulation of the stripping reaction below the Coulomb barrier between complex nuclei is presented using the theory of the Coulomb excitation. The importance of the effect of the Coulomb stripping without the target excitation is emphasized. With a proper choice of the closest approach distance the transition amplitude with the Coulomb excitation of the target nucleus becomes comparable with that without the Coulomb excitation. (auth) (France)

18032 APPLICATION OF THE SHAPIRO MODEL AND OF THE THREE-BODY THEORY TO $(\alpha,2\alpha)$ REACTIONS. Burdet, G.; Perrin, M. (Univ., Lyon). J. Phys. (Paris), Colloq.; 31: Suppl. No. 5-6, C2.190-1(May-Jun 1970). (In French).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France. See CONF-700313.

From the three-body theory, it is shown that the pole graph and the triangular graph of the dispersion model must appear always together in the meaningful transition amplitude describing the $(\alpha,2\alpha)$ break-up reactions. (auth) (France)

18033 ON A POSSIBLE CONSISTENCY CHECK FOR THE BOHR VIBRATIONAL MODEL. Miranda, A. (Univ. of Aarhus, Denmark). Nucl. Phys.; A157: 404-16(1970).

From an interpretation of what is meant by a vibrational band in a nucleus, fully consistent with the Bohr vibrational model, and indeed implied by this model, a dispersion formula is obtained. This establishes a relationship between certain measurable quantities. When the available relevant information for Pb and Hg isotopes is inserted into this formula, it is nearly satisfied in one important case, but it fails in all the other cases considered. (auth)

18034 A COMPARISON BETWEEN TWO METHODS FOR ISOBARIC ANALOGUE RESONANCES. Bund, G. W. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Nucl. Phys.; A157: 369-84(1970).

The models of Toledo Piza and Kerman (OC) and Blair and Bund (NOC) were compared analytically as well as numerically, the former being here generalized to include the inelastic channels. These models are very similar and differ mainly in that OC requires orthogonality between the channel part and the analogue part of the wave function. Both methods were applied to elastic and inelastic proton scattering at the IAR of the ground state of ^{208}Pb and to elastic scattering at several IAR of ^{91}Zr. A further comparison was made if OC is generalized by including the appropriate anti-analogue states. The resonance widths obtained were also compared to experiment. (auth)

18035 REMARK ON THE RELATION BETWEEN THE GENERATOR-COORDINATE METHOD AND THE RANDOM-PHASE APPROXIMATION. da Providencia, J. (Univ., Coimbra, Portugal). Nucl. Phys.; A157: 358-62(1970).

The equivalence between the generator-coordinate method and the random-phase approximation was established by several authors. It is shown that a trial wave function $\phi(x;a)$, dependent on the time by the parameter $a = a(t)$, oscillates in time with a frequency that is also given by the equations provided by both the generator-coordinate method and the RPA for the excitation energy. (auth)

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REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstract 18219.

18036 PROCEEDINGS OF THE AMERICAN POWER CONFERENCE. VOLUME 32. Thirty-Second Annual Meeting, Chicago, April 21, 22, 23, 1970. Chicago; American Power Conference (1970). 1191p. $15.00. (CONF-700426).

The technical, economic, and social aspects of the generation, transmission, distribution, and utilization of electric power are discussed. A separate abstract was prepared for each of 28 papers on the application of nuclear energy for power production. (H.D.R.)

For abstracts of individual papers see: 15745, 18037–18046, 18066–18073, 18102–18106, 18145, 18149, 18158, and 18164.

18037 NUCLEAR POWER: STATUS AND OUTLOOK. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). Proc. Amer. Power Conf.; 32: 25-37(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The status and outlook for the operation of nuclear power plants in the U. S. are discussed. Emphasis is placed on the program for development of a Liquid Metal Fast Breeder Reactor and its implications to future power production capacity. Environmental aspects of electricity production from both nuclear and non-nuclear plants are examined. (H.D.R.)

18038 ELECTRIC POWER PHILOSOPHY FOR THE 1970s. Hamil, David A. (Dept. of Agriculture, Washington, D. C.). Proc. Amer. Power Conf.; 32: 38-44(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

A philosophy of cooperation and joint planning between U. S. power utilities in installing future capacity is presented. This joint planning is predicted to provide both protection of the environment and maximum economic usage of costly new facilities. (H.D.R.)

18039 MAJOR ELECTRIC POWER FACILITIES AND THE ENVIRONMENT. Coe, Robert N. (Southern California Edison Co., Los Angeles). Proc. Amer. Power Conf.; 32: 52-60(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The environmental considerations applied to the planning and installation of U. S. electric power facilities are summarized. (H.D.R.)

18040 DAVIS–BESSE NUCLEAR POWER STATION. Roe, L. E. (Toledo Edison Co.); McFarland, J. Proc. Amer. Power Conf.; 32: 210-23(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The Davis–Besse power station site and general plant layout are described, and the personnel training and project schedules are presented. The pressurized water reactor steam supply system, the engineered safety features, and the nuclear instrumentation and control system are described. (H.D.R.)

18041 PALISADES PLANT: DESIGN AND CONSTRUCTION. Swarts, K. A. (Consumers Power Co., Jackson, Mich.); Hall, V. C. Jr.; Rumbaugh, E. A. Proc. Amer. Power Conf.; 32: 224-32(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The basic layout of the Palisades plant is described, and the steam and power conversion system is examined. Design parameters of the pressurized water reactor and safety systems are discussed. (H.D.R.)

18042 INFORMATION REQUIREMENTS AND THEIR IMPACT ON NUCLEAR POWER PLANT DESIGN AND CONSTRUCTION. Lester, William (Westinghouse Electric Corp., Pittsburgh). Proc. Amer. Power Conf.; 32: 267-75(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

Requirements for management tools to accomplish the complex tasks of nuclear power plant design and construction are discussed. The key elements in a properly planned and managed nuclear project are the establishment of an integrated management team to avoid delays in engineering, licensing, and procurement and the standardization of design, licensing, and startup procedures. (H.D.R.)

18043 NUCLEAR WASTE MANAGEMENT PRACTICES AND TRENDS. Jason, R. H.; Ward, J. E. (Sargent and Lundy, Engineers, Chicago). Proc. Amer. Power Conf.; 32: 276-85 (1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

Methods employed in light-water reactors to process radioactive wastes are discussed. Sources of wastes are examined, and management systems for both gaseous and liquid wastes are described. (H.D.R.)

18044 POWER AND THE ENVIRONMENT. Wright, J. H. (Westinghouse Electric Corp., Pittsburgh). Proc. Amer. Power Conf.; 32: 487-98(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The environmental impact of both pressurized-water reactor and fossil-fuel types of steam electric power plants is briefly discussed. The potential problems from radioactive emissions, air pollution, and heat discharges are described. (H.D.R.)

18045 AIR POLLUTION AND POWER GENERATION. Wetch, Joseph R. (North American Rockwell Corp., Canoga Park, Calif.). Proc. Amer. Power Conf.; 32: 504-11(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The estimated levels of air pollutants released in the U. S. from all sources are presented. Projections for emission levels of sulfur and nitrogen compounds from fossil-fueled power plants are made, and the effects of emission control methods are discussed. Some promising control methods under development are described. (H.D.R.)

18046 PRODUCING LOW CHLORIDE EFFLUENT WITH LOW REGENERANT WASTE VOLUMES BY CONDENSATE MIXED-BED POLISHERS IN NUCLEAR CYCLES. White, Jacqueline V.; Crits, George J. (Crane Co., King of Prussia, Pa.). Proc. Amer. Power Conf.; 32: 771-85(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

Operating high-rate hydrogen-cycle mixed-bed condensate polishing plants at the Oyster Creek Nuclear Power Plant, Unit 1 and at a fossil fuel power plant were evaluated. The effectiveness of these plants for producing high purity effluents is described. (H.D.R.)

18047 GAMMA-CHAMBERS APPLICATION TO POWER MEASUREMENTS OF REACTOR FUEL CHANNELS OF THE I. V. KURCHATOV BELOYARSK NUCLEAR POWER STATION. Emel'yanov, I. Ya.; Alekseev, V. I.; Konstantinov, L. V.; (and others). At. Energ. (USSR); 29: 327-30(Nov 1970). (In Russian).

The gamma-intensity method to measure power density distribution in the reactor core is described. Calculations and experimental results are given. Ionization gamma-chambers have been used as sensing elements to measure fuel channel power of the reactor. Measurement errors are evaluated. The analysis of test gamma-chambers operation makes it possible to recommend them as promising sensing devices of operation control systems for power density distribution measurement in tube-type reactors. (12 references) (auth)

18048 ECOLOGY AROUND A REACTOR. Auerbach, S. I. (Oak Ridge National Lab., Tenn.). Oak Ridge Nat. Lab. Rev.; 3: No. 5, 23-8(Fall 1970).

Some of the studies in progress and some results from these studies on the environmental impact of low-level releases of radionuclides and thermal effluent releases are described. The effects of these environmental factors on the design and siting of nuclear power plants are discussed. (H.D.R.)

18049 1971 NUCLEAR POWER SALES OUTLOOK. Nucl. Ind.; 18: 3-6(Jan 1971).

18050 PLANNING FOR NUCLEAR POWER IN PAKISTAN. Usmani, Ishrat Husain. Com. Naz. Energ. Nucl., Notiz.; 16: No. 11, 41-56(Nov 1970). (In Italian).

The situation of nuclear power now and in the seventies in Pakistan is reviewed. (auth)

18051 CONSIDERATIONS ON THE APPLICATION AND ADAPTABILITY OF COMPUTER CONTROL TO NUCLEAR POWER PLANTS. Keddar, A. (International Atomic Energy Agency, Vienna). At. Energy Rev.; 8: 957-66(Dec 1970).

Because of their adaptability, economy and reliability, digital computers are becoming of increasing interest in the control and operation of nuclear power plants. The following aspects of their application are discussed: safety and control, their functions; performance and their reliability; economy; operator's role; comparison with analog computers. (16 references) (auth)

18052 ILLUMINATION OF MIHAMA NUCLEAR POWER PLANT MACHINE NO. 1. Kaneseki, Isamu (Mitsubishi Electric Corp., Osaka). Mitsubishi Denki Giho; 44: 1478-84(Nov 1970). (In Japanese).

Mihama nuclear power plant No. 1 of the Kansai Electric Power Co., where Mitsubishi participated in the design of the illumination and delivered lighting fixtures, has been completed and scheduled to enter into commercial operation. The illumination of the nuclear power plant is not basically different from that of thermal power plants except for the primary system. With the primary system, it needs thorough consideration on the construction, finish, and performance against earthquake, corrosion, and other failures. The illumination of the whole installation of the PWR power plant is described with emphasis on the illumination of the containment. (auth) (Japan)

18053 STARTUP OF POWER STATIONS IN EXCESS OF 100 MW IN THE FEDERAL REPUBLIC OF GERMANY FOR THE YEARS 1969 TO 1974. Atomwirt., Atomtech.; 15: 591(Dec 1970). (In German).

Fossil fueled and nuclear power plants are tabulated by year of startup, owner/contractor, power level, and fuel type. (H.D.R.)

18054 INFLUENCE OF TECHNOLOGICAL INNOVATIONS ON THE INDUSTRIAL DEVELOPMENT OF VARIOUS PHASES OF THE NUCLEAR FUEL CYCLE. Girotti, R. (ENI, Rome). pp 337-42 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970). (In Italian).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

18055 SURVEY SHOWS NUCLEAR PLANTS WILL LIMIT POLLUTING EFFLUENTS. Schwieger, Robert G. Power; 115: No. 1, 49-53(Jan 1971).

Worldwide nuclear power plants that were planned, under construction, or operating as of the end of 1970 are tabulated. Many of the design features of the plants are listed with emphasis on methods for control of releases of thermal and radioactive effluents. (H.D.R.)

18056 CONSTRUCTION OF THE NUCLEAR POWER PLANT. THE PROBLEM OF CONSTRUCTION OF THE NUCLEAR POWER PLANT. Takemura, T. (Japan Atomic Power Co., Tokyo). Genshiryoku Kogyo; 16: No. 8, 6-10(Aug 1970). (In Japanese).

Problems in the civil engineering and construction works in nuclear power stations are described in the following: the site and associated investigations, including plant location, and geological (seismic), water-supply, and surveys; safety of the power station, involving earthquake, shielding, environmental contamination and containment vessel; the schedule for construction works; utilization of prestressed concrete; construction works, including structural design and cooling-water intake from the sea and its release; and combination with a pumping-up power plant. (Japan)

Operation and Economics

18057 (BNL-50235) POWER PLANT OPERATING AND MAINTENANCE COSTS. Susskind, H.; Raseman, C. J. (Brookhaven National Lab., Upton, N. Y.). Apr 1970. 90p. Dep. NTIS.

Power plant operating and maintenance cost data are presented for a number of reactor systems — LWR, HTGR, MSBR, LMFBR, and GCFR. Also presented for comparison purposes are similar data for fossil-fueled plants. The cost data are reviewed and the unique features of each reactor system influencing the operating and maintenance costs are identified. The results are summarized and tentative conclusions drawn. 25 references. (auth)

18058 (DOCKET-1155-8) LA CROSSE BOILING WATER REACTOR. Monthly Operational Report No. 26, August 1969. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Oct. 10, 1969. 50p. (ACNP-69508). Dep. CFSTI.

18059 (DOCKET-1155-9) LA CROSSE BOILING WATER REACTOR. Twenty-Eight Day Warranty Operation Report. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Oct. 1969. 13p. (ACNP-69509). Dep. CFSTI.

18060 (DOCKET-1155-99) LA CROSSE BOILING WATER REACTOR. Inspection of Fuel in November 1970. (Dairyland Power Cooperative, La Crosse, Wis.). Jan 1971. 51p. (DPC-851-20). Dep. NTIS.

18061 (DOCKET-50171-77) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 58, December 1970. (Philadelphia Electric Co., Pa.). 10 Feb 1971. 12p. Dep. NTIS.

18062 (DOCKET-50219-122) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Surveillance Test Failure of Vacuum Breaker Block Valves. (Jersey Central Power and Light Co., Morristown, N. J.). 8 Feb 1971. 3p. Dep. NTIS.

18063 (GA-10400) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR POSTCONSTRUCTION RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending October 31, 1970. (Gulf General Atomic, Inc., San Diego, Calif.). 30 Nov 1970. Contract AT(04-3)-314. . 46p. Dep. NTIS.

FISSION PRODUCTS — release rates in helium cooled reactor
PEACH BOTTOM POWER REACTOR, UNIT 1 — operations during August to October 1970
— physics measurements for Core 2
— control rods for Core 2, reactivity worth measurements of
— coolant purification system for, performance of helium
REACTOR CONTROL ELEMENTS — reactivity worth of gas cooled rod type (D.C.C.)

18064 (LIB/Trans-322) DEFECTS IN NUCLEAR POWER STATIONS: AN ANALYSIS. Feldman, J. Translated by Fritz Hille for Australian Atomic Energy Commission, from Atomwirt. [Atomtech.]; 14: 446-8(Sep-Oct 1969). 8p. Dep. NTIS (U. S. Sales Only).

Failure data on components and systems of 43 nuclear power plants are analyzed. The plants surveyed included 16 light water reactors, 6 heavy water reactors, 16 gas cooled reactors, and 5 sodium cooled reactors. Failures resulting in repair costs of more than $10,000 or a plant down-time of over 4 days are tabulated for fuel elements, control rods, pressure vessels, heat exchangers, pumps, blowers, and conventional power plant components. (H.D.R.)

18065 (TID-25663) GUNDREMMINGEN NUCLEAR POWER PLANT MONTHLY REPORT, NOVEMBER 1970. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 21 Dec 1970. 42p. (In German). Dep. NTIS.

The plant was operated at full load without limitation. Half way through the month the load had to be reduced briefly to change the control rod withdrawal sequence. The shipment of irradiated fuel elements was initiated. In addition, the first tank of active sludge was taken to Karlsruhe. Certain difficulties in connection with the decontamination of the element transport container were overcome. The activity of the reactor water and waste gas remained constantly low. (auth)

18066 SIMULATION OF THE UNITED STATES POWER ECONOMY. Deonigi, D. E. (Battelle-Northwest, Richland, Wash.). Proc. Amer. Power Conf.; 32: 105-15(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The potential for various power reactor systems in the U. S. electrical power economy is examined. A computer model developed for simulating the power economy and some results of simulated systems are described. (H.D.R.)

18067 FITTING NUCLEAR CAPACITY INTO UTILITY PLANNING. Gilleland, J. E. (Tennessee Valley Authority, Chattanooga); Hoskins, R. E.; Kiefer, W. M.; Koncel, E. F. Proc. Amer. Power Conf.; 32: 116-22(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

Some of the basic considerations in advance planning of electric utility operation to include nuclear units are discussed. (H.D.R.)

18068 METHODS OF PLANNING GENERATING UNIT OPERATION. Anderson, S. W. (Commonwealth Edison Co., Chicago); Jenkins, R. T.; Joy, David; Merrill, E. T.; Wolsko, T. D. Proc. Amer. Power Conf.; 32: 123-30(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

Dynamic and linear programming techniques were applied to the problem of loading generating units for a typical week. The efficiency and flexibility of these techniques were evaluated and compared to other production cost methods. (17 references) (H.D.R.)

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18069 BWR STARTUP EXPERIENCE IN 1969. Christfanson, R. C.; Keller, J. M.; Willett, D. K. (General Electric Co., San Jose, Calif.). Proc. Amer. Power Conf.; 32: 164-9(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The startup test programs and results are summarized for the Oyster Creek, Tarapur, Nine Mile Point, and Tsuruga boiling water reactors. (H.D.R.)

18070 STARTUP AND POWER ESCALATION AT THE R. E. GINNA NUCLEAR POWER PLANT. Koprowski, Robert R. (Rochester Gas and Electric Corp., N. Y.); White, Leon D.; Powell, Edward U.; Cameron, Paul M. Proc. Amer. Power Conf.; 32: 170-87(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The basic design and performance characteristics of the Ginna plant Unit 1 are reviewed. The startup program is described, and the role of the owner in plant construction and startup is discussed. (H.D.R.)

18071 STARTUP AND OPERATION OF THE SAN ONOFRE NUCLEAR GENERATING STATION UNIT ONE. Haynes, J. G. (Southern California Edison, San Clemente, Calif.). Proc. Amer. Power Conf.; 32: 188-93(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The startup test program for the San Onofre plant is reviewed and the initial operating history is presented. Performance of the steam generators and in-core instrumentation is discussed. (H.D.R.)

18072 SAN ONOFRE PWR CORE OPERATIONS FOLLOW. Hughes, F. R.; Langford, F. L. Jr. (Westinghouse Electric Corp., Pittsburgh). Proc. Amer. Power Conf.; 32: 194-9(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The surveillance of reactor core performance over the first 10,000 MWd/MTU of operation is described. Results of determinations of the reactivity coefficients and core power distribution are presented. (H.D.R.)

18073 CANADIAN OPERATING EXPERIENCE WITH HEAVY-WATER POWER REACTORS. Lewis, W. Bennett (Atomic Energy of Canada Ltd., Chalk River, Ont.); Foster, John S. Proc. Amer. Power Conf.; 32: 200-9(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

Operating experience with the NPD and Douglas Point reactors is briefly reviewed. Performance of fuel elements, heavy-water and tritium release control measures, on-line refueling machines, heat exchangers, and pumps is discussed. (H.D.R.)

18074 STUDIES ON THE OVERLOAD OPERATION OF RHEINSBERG NUCLEAR POWER PLANT. Schoenherr, A.; Maresch, W. (VEB Kernkraftwerk, Rheinsberg, Ger.). Kernenergie; 13: 355-60(Nov 1970). (In German).

Power reserves of the main aggregates and systems of the Rheinsberg nuclear power plant were obtained aiming to an increase of electrical power with low additional investment. Both theoretical and practical methods of investigation and results are presented. Taking the power-limiting plant components into account, an increase of electrical power from 70 up to 80 MW has been made possible. An evaluation of the experimental operation with increased power realized so far was made. (5 references) (auth)

18075 OPTIMIZATION OF DEVELOPING ATOMIC POWER PLANT SYSTEM TAKING INTO ACCOUNT LOAD FACTOR CHANGE. Frankovski, V. (Inst. for Nuclear Research, Swierk, Poland). At. Energ. (USSR); 29: 330-7(Nov 1970). (In Russian).

Optimization of the structure of nuclear power systems considering the load factor changes can be resolved using linear programming methods in the cases in which the established nuclear power does not exceed 25 to 30% of the total established power. However, in the event the established nuclear power exceeds a certain fraction of the established total power it becomes necessary to use the nuclear power system in alternating regime during the period of load changes. A mathematical model is suggested for resolving such problems. (R.V.J.)

18076 INDIA IS INTENDING TO USE NUCLEAR ENERGY. Friese, J. VDI (Ver. Deut. Ing.) Nachr.; 24: No. 32, 1(12 Aug 1970). (In German).

The development of nuclear power plants in India is reviewed. Economic production of electricity is analyzed. (INIS)

18077 IMPACT OF THE NEW DEVELOPMENTS ON ECONOMICS AND INDUSTRIAL PROGRESS. Lloyd, B. C. J. (Rio Tinto-Zinc Corp. Ltd., London). pp 317-24 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

Economic factors related to the development and operation of nuclear power plants are analyzed. (D.C.C.)

18078 OPERATING EXPERIENCES WITH NUCLEAR POWER STATIONS IN THE MEMBER COUNTRIES OF UNIPEDE. Sani, Luciano (ENEL, Rome); Stolz, Jean; Weeks, Robert. At. Strom; 16: 152-6(Oct 1970). (In German).

After summarising operating experiences with nuclear power stations on the basis of an investigation by the study committee for thermal generation, general hints relating to experiences with the efficiency of the primary circuit, fuel efficiency and the monitoring of radiation and contamination are presented. (auth)

18079 NUCLEAR POWER GENERATION FACES SERIOUS PROBLEMS AS TO ECONOMIC TREND IN THE U.S.A. Takei, Mitsuo (Japan Energy Economic Research Inst., Tokyo). FAPIG (Tokyo); No. 56, 216-23(Mar 1970). (In Japanese).

It is reported that the nuclear power economy in the U.S.A. faces serious problems. Some of the principal reasons for the downtrend in the order for nuclear power plants during the past few years are rising construction cost, the delayed delivery of large machinery, the delay of on-site construction, and the escalation of labor and material costs. At the same time, the added cost for the increasing requirement of safety and the prevention of public nuisance must not be overlooked. The situation is particularly difficult to simplify, because the inherent status of nuclear power is connected tightly with energy problems and the other factors in economics. (Japan)

Safety and Siting

18080 (BNWL-SA-3665) NUCLEAR POWER AS A SOURCE OF CONTAMINATION ON A GLOBAL SCALE. Unruh, C. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec 1970. Contract AT(45-1)-1830. 16p. (CONF-701205-2). Dep. NTIS.

From Washington Ecological Commission Conference, Richland, Wash.

The anticipated growth in electricity generation requirements between 1970 and 2000 is discussed and the increasing role of nuclear power in meeting these requirements is described. The two radionuclides generated by nuclear power plants that would contribute most to global contamination under present release practices are tritium and ^{85}Kr. Levels of production of these two radioisotopes are projected, and doses resultant to man are tabulated. Areas of study needed to indicate the degree of containment required for tritium and krypton are outlined. 14 references. (H.D.R.)

18081 (BRH/OCS-70-1) RADIATION EXPOSURE OVERVIEW: NUCLEAR POWER REACTORS AND THE POPULATION. Oates, William H. Jr. (Bureau of Radiological Health, Rockville, Md.). Jan 1970; Reprinted Aug 1970. 30p.

The overview provides information regarding the radiological health aspects of nuclear power reactors. In addition to broadly documenting the exposures associated with this source of radiation, information presented may be useful for comparing the estimated radiation exposure of the public with that from other sources of environmental exposure. Data are included on the quantities of radioactivity discharged from nuclear power reactors to the environment and comparisons are made with applicable radiological health standards. 43 references. (auth)

18082 (DOCKET-50155-64) BIG ROCK POINT NUCLEAR PLANT. License No. DPR-6; Proposed Technical Specifications Change No. 25, Additional Information. (Consumers Power Co., Jackson, Mich.). 9 Feb 1971. 3p. Dep. NTIS.

Additional information concerning the use of neutron sources during reactor startup is presented. (D.C.C.)

18083 (DOCKET-50155-66) BIG ROCK POINT NUCLEAR PLANT. License No. DPR-6; Technical Specifications Change No. 22. (Division of Reactor Licensing (AEC), Washington, D. C.). 9 Feb 1971. 4p. Dep. NTIS.

Revised technical specifications concerning operations with an instrumented Reload-F fuel bundle are presented. Design parameters of the fuel bundle are listed. (D.C.C.)

18084 (DOCKET-50271-37) VERMONT YANKEE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 19 (Includes Additional Revisions to Final Safety Analysis Report). (Vermont Yankee Nuclear Power Corp., Rutland). 4 Feb 1971. 73p. Dep. NTIS.

Revised design parameters of the Vermont Yankee Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

18085 (DOCKET-50285-40) FORT CALHOUN REACTOR. Pre-Operational Environmental Survey. Eighth Report, 3rd Quarter 1970. (Trapelo/West, Richmond, Calif.). 25 Nov 1970. 25p. Dep. NTIS.

For Omaha Public Power District, Nebr.

18086 (DOCKET-50285-41) FORT CALHOUN REACTOR. Pre-Operational Background Radiological Survey. Summary Report, October 1968-October 1970. (Trapelo/West, Richmond, Calif.). 13 Jan 1971. 41p. Dep. NTIS.

For Omaha Public Power District, Nebr.

18087 (DOCKET-50302-17) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Preliminary Safety Analysis Report, Amendment 11. (Florida Power Corp., St. Petersburg). 25 Jan 1971. 3p. Dep. NTIS.

A statement concerning the listing of the Final Safety Analysis Report as Amendment No. 11 to the Preliminary Safety Analysis Report is presented. (D.C.C.)

18088 (DOCKET-50302-18) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Preliminary Safety Analysis Report, Amendment 11 (Includes Final Safety Analysis Report, Vol. 1). (Florida Power Corp., St. Petersburg). 25 Jan 1971. 285p. Dep. NTIS.

Information on Crystal River Power Reactor Unit 3 is presented under the headings of general design parameters and site and environment. (D.C.C.)

18089 (DOCKET-50302-19) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Preliminary Safety Analysis Report, Amendment 11 (Includes Final Safety Analysis Report, Vol. 2). (Florida Power Corp., St. Petersburg). 25 Jan 1971. 396p. Dep. NTIS.

Information on Crystal River Power Reactor Unit 3 is presented under the following main headings: reactor; reactor coolant system; and containment system. (D.C.C.)

18090 (DOCKET-50302-20) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Preliminary Safety Analysis Report, Amendment 11 (Includes Final Safety Analysis Report, Vol. 3). (Florida Power Corp., St. Petersburg). 25 Jan 1971. 219p. Dep. NTIS.

Information on Crystal River Power Reactor Unit 3 is presented under the following main headings: containment structure integrity testing; instrumentation and control; and electrical systems. (D.C.C.)

18091 (DOCKET-50302-21) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Preliminary Safety Analysis Report, Amendment 11 (Includes Final Safety Analysis Report, Vol. 4). (Florida Power Corp., St. Petersburg). 25 Jan 1971. 189p. Dep. NTIS.

Information on Crystal River Power Reactor Unit 3 is presented under the following main headings: auxiliary and emergency systems; steam and power conversion system; radioactive waste and radiation protection; conduct of operations; and initial tests and operations. (D.C.C.)

18092 (DOCKET-50302-22) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Preliminary Safety Analysis Report, Amendment 11 (Includes Final Safety Analysis Report, Vol. 5). (Florida Power Corp., St. Petersburg). 25 Jan 1971. 276p. Dep. NTIS.

Information on Crystal River Power Reactor Unit 3 is presented under the following headings: safety analysis; iodine removal capabilities of reactor building spray system; and post-accident purging for reactor building hydrogen control. (D.C.C.)

18093 (DOCKET-50331-13) DUANE ARNOLD ENERGY CENTER. Preliminary Safety Analysis Report, Amendment 7. (Iowa Electric Light and Power Co., Cedar Rapids). Oct. 14, 1969. 115p. Dep. CFSTI.

Revised design parameters of the Duane Arnold Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

18094 (NP-18622) CONTROL OF RADIOACTIVE WASTE FROM NUCLEAR FACILITIES. Aurand, K.; Arndt, J.; Ruehle, H.; Wolter, R. (Bundesgesundheitsamt, Berlin (West Germany). Institut fuer Wasser-, Boden- und Lufthygiene). Aug 1970. 26p. (In German). Dep. NTIS (U. S. Sales Only).

The research showed that the radioactive waste in the discharge building at Obrigheim was completely mixed with the coolant water. This waste is mixed under the research conditions with the strongest in the first 500 m flow stretch in flowing water; after about 4 km the dilution corresponds to that expected from the calculations; from 11.5 km up to the dam stage Rockenau only a slight additional dilution occurs. About 40% of the ^{133}Xe escapes in the first 600 m flow length and 50% within the first 2.5 km. The degassing is then delayed and increases first in the passage through the Guttenbach power plant (72.2 km). At the Rockenau Dam 75% of the ^{133}Xe had escaped. The activity registered at the Rockenau Dam consists of 95% from ^{133}Xe. The increased activity measured in the spring of 1969 in Rockenau was attributed to the drainage of radioactive rare gases with the wastes. (tr-auth)

18095 (WHAN-SA-38) PREVENTION OF FAILURE. Norris, J. M. (WADCO Corp., Richland, Wash.). 8 Sep 1970. Contract AT(45-1)-2170. 42p. (CONF-700904-3). Dep. NTIS.

From Conference on Power Reactor Systems and Components, Williamsburg, Va.

The requirements of a quality assurance program for construction and operation of a nuclear power plant are reviewed. (D.C.C.)

18096 THERMAL INVESTIGATIONS IN CALIFORNIA. Adams, J. R.; Gormly, H. J.; Doyle, M. J. (Pacific Gas and Electric Co., San Francisco). Mar. Pollut. Bull.; 1: 140-2(Sep 1970).

Many of the conflicting statements concerning effects of thermal effluents are brought about by discrepancies between laboratory projections and field evidence. Research techniques used at fourteen nuclear power plants from Humboldt Bay to Morro Bay are considered. Current measurements by dye dispersion, research into the thermal tolerance of fish, and quantification of fauna are described. Thermal dispersion measurements by an infrared airborne radiometer are discussed and a benthic survey made of Monterey Bay by PONAR grab systems described. The effects of the Diablo Nuclear Power Plant are predicted based on laboratory models and field studies at a similar nuclear power plant, and were verified at Morro Bay. The effects of thermal influence were found to be measurable only in the immediate vicinity of the discharge and were dissipated within a short distance. Investigations at other similar sites are also considered. (UK)

Steam and Power Conversion Systems

18097 TRACER TESTS FOR NUCLEAR POWER PLANT STEAM TURBINES. Cotton, K. C. (General Electric Co., Schenectady, N. Y.); Herzog, W. G.; Gilbert, R. S.; Holloway, J. H.; Morris, F. S. Mech. Eng.; 93: 15-19(Jan 1971).

The application of tracer techniques to the measurement of either the water phase or the wetness fraction of a two-phase vapor-water flow is discussed. Tests conducted on the turbines of the Dresden plant are described. The feasibility of using such radioactive tracer techniques for accurate, less expensive determinations of wet steam enthalpy was proven. (H.D.R.)

Power Reactor Development

Refer also to abstracts 15967 and 18180.

18098 (BNWL-1522-1) AEC REACTOR DEVELOPMENT AND TECHNOLOGY PROGRAMS. Technical Activities Quarterly Report, July-September 1970. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1970. Contract AT(45-1)-1830. 130p. Dep. NTIS.

CRITICAL ASSEMBLIES—reactivity measurements in multizone, method for determination of neutron lifetime for
FISSION PRODUCTS—diffusion in mixed oxide fuels during irradiation
GRAPHITE—radiation effects on chemical and physical properties of, in-pile
HIGH TEMPERATURE LATTICE TEST REACTOR—physics measurements in HTGR-type lattices in
HIGH TEMPERATURE LATTICE TEST REACTOR—safety rods in, technique for measurement of deformation in
PHYSICAL CONSTANTS TESTING REACTOR—neutron cross section evaluation in, use of Fast Neutron Cavity for
PLUTONIUM—diffusion in mixed oxide fuels during irradiation

PLUTONIUM OXIDES PuO_2—criticality parameters of unmoderated plutonium-240 enriched, effects of composition and configuration on
—PuO_2–UO_2, irradiation testing of recycle fuels of
PLUTONIUM RECYCLE TEST REACTOR—fuels for, irradiation performance of mixed oxide
REACTOR FUEL ELEMENTS—coolant flow and heat transfer in rod bundle, computer code development for
—performance during power transients, effects of plutonium oxide (PuO_2) particle size on mixed oxide
—neutron dose rates and yields from mixed oxide recycle
—gamma dose rates from mixed oxide recycle
—radiation testing of Zircaloy clad plutonium oxide (PuO_2)–uranium oxide (UO_2)
REACTOR FUELS—radiation effects on fission product and plutonium migration in mixed oxide
—burnup of mixed oxide, analysis of neutron cross section ratios from
REACTORS, WATER MODERATED—reactivity of mixed oxide fueled, effects of plutonium oxide (PuO_2) particle size on
URANIUM OXIDES UO_2—PuO_2–UO_2, irradiation testing of recycle fuels of (H.D.R.)

18099 (GA–10313) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending September 30, 1970. (Gulf General Atomic, Inc., San Diego, Calif.). 30 Oct 1970. Contract AT(04-3)-633. 234p. Dep. NTIS.

BOILERS—development of gas cooled reactor
BORON—removal from boronated Type 304 stainless steel, effects of steam on
FISSION PRODUCTS—release from coated particle fuels, (E)
FORT ST. VRAIN POWER REACTOR, UNIT 1—remote viewing equipment for, temperature testing of television
—thermal insulation for, performance of
—fuel cycle management program for, development of
—physics parameters analysis for
—fuel element design and testing for
—fuel element for, properties and irradiation stability of graphite in
—core for, properties and irradiation stability of graphite in
—fuels for, preparation and testing of coated particle
—control materials for, shattering characteristics of boronated graphite spheres
—shielding materials for, effects of steam on boron loss from boronated Type 304 stainless steel
—loading machine for, development of
—boiler for, development and testing of
GRAPHITE—tensile properties of H-327 and HLM 85
—radiation effects on, fast neutron, (E)
—structural stability of boronated spheres of
NEUTRONS, FAST—effects on coated particle fuels, (E)
—effects on properties of graphite, (E)
REACTOR FUELS—fabrication methods for coated particle type, (E)
—radiation effects on coated particle type, fast neutron, (E)
REACTOR LOADING MACHINES—development of gas cooled reactor
STAINLESS STEEL—corrosion of boronated Type 304, effects of steam on boron loss during
STEAM—corrosive effects on boronated Type 304, stainless steel
TELEVISION EQUIPMENT—development for in-vessel viewing of gas cooled reactor
THERMAL INSULATION—development of gas cooled reactor pressure vessel
THORIUM CARBIDES—ThC_2–UC_2, irradiation testing of coated particles (D.C.C.)

18100 (ORNL–4622) MOLTEN-SALT REACTOR PROGRAM. Semiannual Progress Report for Period Ending August 31, 1970. (Oak Ridge National Lab., Tenn.). Jan 1971. Contract W-7405-eng-26. 230p. Dep. NTIS.

Progress during March to September 1970 in the operation of the Molten Salt Reactor Experiment, design and development of the Molten Salt Breeder Reactor, molten salt chemistry, materials development, and molten salt processing and preparation is reported. A separate abstract was prepared for each of 5 sections. (H.D.R.)

For abstracts of individual sections see: 15625, 15726, 16399, 18101, and 18148.

18101 (ORNL–4622, pp 7-59) MSBR DESIGN AND DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

From Molten-Salt Reactor Program.

FISSION PRODUCTS—removal from molten salt reactor fuels, development of system for gaseous
GLYCEROL—glycerol–H_2O, mass transfer coefficients for helium bubbles in, (E/T)
HELIUM—mass transfer coefficients for bubbles of, in glycerol-water mixtures, (E/T)
LOOPS—operation of sodium fluoroborate salt circulation, detection of water additions in, (E)
MOLTEN SALT BREEDER EXPERIMENT—steam generator development for
—heat exchangers for, afterheat temperatures in empty, (T)
—fuel salt for, neutron capture to absorption ratio for uranium-233 in, (E/T)
MOLTEN SALT BREEDER REACTOR—design concept for 300 MW(e) prototype
—physics parameters of, effects of thorium concentration in fuel salt on, (T)
—fuel cycle costs for, effects of thorium concentration in fuel salt on, (T)
—performance of 300 MW(E) fixed-moderator, with batch fuel processing and plutonium feed, (T)
—fuel salt for, development of gaseous fission product removal system for
—operation at part-load, steady-state characteristics during, (T)
—fuel salt for, heat transfer and thermophysical properties of, (E/T)
NEUTRONS—capture to absorption ratio for uranium-233 in circulating molten salt reactor fuel, (E/T)
URANIUM-233—neutron capture to absorption ratio for, in circulating molten salt reactor fuel, (E/T)
WATER—glycerol–H_2O, mass transfer coefficients for helium bubbles in, (E/T)
WELDING—development of automatic, for remote fabrication and maintenance of reactor components (H.D.R.)

18102 FAST-BREEDER REACTOR DEVELOPMENT IN THE UNITED STATES FROM A UTILITY POINT OF VIEW. Staszesky, Francis M.; Pursel, Claude A. (Boston Edison Co.). Proc. Amer. Power Conf.; 32: 131-43(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The U. S. Liquid Metal Fast Breeder Reactor (LMFBR) Program is examined from the standpoint of a cost comparison with a light water reactor. Various alternate approaches to the LMFBR demonstration plant program are presented, and the role of the utility companies in the program is evaluated. (H.D.R.)

18103 EUROPEAN FAST BREEDER REACTOR PROGRAMS. Nims, John B. (Atomic Power Development Associates, Inc., Detroit). Proc. Amer. Power Conf.; 32: 144-53(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The status of the fast breeder reactor development programs in the United Kingdom, France, Germany, and Italy is briefly examined. (H.D.R.)

18104 LMFBR COMPONENT TECHNOLOGY IN PERSPECTIVE. Koch, L. J. (Argonne National Lab., Ill.); Zitek, C. B. Proc. Amer. Power Conf.; 32: 154-63(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

Progress in the design and development of LMFBR core components, shutdown cooling systems, fuel handling components, heat exchangers, pumps, and instrumentation is reviewed. (H.D.R.)

18105 LARGE HTGR POWER PLANTS. Johnston, T. A. (Gulf General Atomic, San Diego, Calif.). Proc. Amer. Power Conf.; 32: 233-45(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The nuclear steam system availability of the Peach Bottom plant and the major design parameters of the Fort St. Vrain plant are presented. Design and performance characteristics of a typical 1100 MW(e) high-temperature gas-cooled reactor power plant are described. (H.D.R.)

18106 RECENT DEVELOPMENTS IN MOLTEN-SALT REACTORS. Opstad, Melford T. (Northern States Power Co., Minneapolis); Schafer, Karl. Proc. Amer. Power Conf.; 32: 260-6(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

Developments which indicate the potential for building a high-

performance molten salt breeder reactor are reviewed. The developments discussed include: (1) processing of fuels to remove fission-product poisons; (2) improvements in reactor vessel and piping materials; (3) testing of equipment for remote maintenance; (4) use of plutonium fuel; and (5) successful conclusion of the Molten Salt Reactor Experiment operations. (11 references) (H.D.R.)

18107 DEVELOPMENT WORK ON MOLTEN-SALT REACTOR IN THE USA. Com. Naz. Energ. Nucl., Notiz.; 16: No. 11, 99-102 (Nov 1970). (In Italian).

The status of the work started in 1950 in the U.S.A. on the concept of a molten-salt reactor, on which an experiment has been in operation since 1965, is reviewed. (auth)

18108 NUCLEAR REACTORS. Perrett, Robert James; Mackinnon, James Milne; Parker, James Malcolm (to English Electric Co. Ltd.). British Patent 1,217,141. 31 Dec 1970. Filed 7 Feb 1967.

Reference is made to reactors having concrete pressure vessels containing a moderator assembly comprising a stack of graphite blocks arranged in columns, with a side restraining structure encircling the stack. In the arrangement described the stack assembly is supported by bottom support means and by keying means to an internal side wall of the pressure vessel, so as to locate the stack assembly circumferentially relative to the vessel. The bottom support means may be arranged for limited tilting movement, and the restraining structure may include a ring beam around the upper part of the stack, with a member near the bottom of the stack joined rigidly to the ring beam by longitudinal stanchions connected with the stack through link means arranged for limited pivotal movement in a longitudinal plane so as to permit differential movement between the stack and restraining structure in only the longitudinal direction, the keying means being fixed to the ring beam and bottom member. The keying means are preferably arranged for limited movement in a longitudinal plane in response to longitudinal movement between the stack assembly and pressure vessel. The bottom member may be a plate structure that also constitutes part of the bottom support means. (UK)

18109 FAST SODIUM-COOLED REACTOR CORE STRUCTURE. Germer, John H. (to United States Atomic Energy Commission). U. S. Patent 3,549,493. 22 Dec 1970. Filed 22 Jan 1969.

Described is a reactor core structure for a liquid metal cooled fast reactor made up of closely packed hexagonal fuel, blanket and reflector bundles which are held tightly together by an orificing pattern which imposes a higher internal pressure in the outer bundles than in the inner bundles, and which is provided with a hydraulic balancing arrangement whereby a separate unclamping arrangement for refueling is eliminated. Two types of inlet plenums are disclosed; the first with the lower end of the bundle casing apertured for forming the plenum; the second with the bundle casing being removed at the lower end. (auth)

18110 RELIABILITY ANALYSES FOR THE JUDGEMENT OF REACTOR SYSTEMS. Maurer, Hans A. (Generaldirektion Gewerbliche Wirtschaft, Brussels). Tech. Ueberwach.; 10: 412-14(Dec 1969). (In German).

The reliability analysis is a useful means for comparing systems in order to find out possible constructive defects in the design of a circuit and to point out measures of improvement. Due to the errors in empirically determined data no quantitative data can be obtained yet. When using calculating formulas care must be taken to make sure that the simplifications made are also practicable for the case in question. It is considered necessary to collect a large number of representative data. Since no quantitative information concerning the safety of a system or a total analysis is possible yet with the means available a reliability analysis cannot yet be used as a basis for an authorization procedure. (auth)

18111 TWO-DIMENSIONAL BURNUP ANALYSIS OF FUEL ASSEMBLY IN A BOILING WATER REACTOR. Yata, Minoru; Watanabe, Takao; Kawamoto, Tadao. Sumitomo Elec. Tech. Rev.; No. 14, 126-30(Nov 1970).

An assembly of a boiling water reactor has local compositions such as burnable poisons, several kinds of fuel rods with different enrichment, and wide water gaps surrounding the fuel rods. Because of these compositional influences, the neutron energy spectrum changes considerably as a function of position in an assembly. The effects on the neutron energy spectrum of the complex geometry and various compositions were estimated. The average nuclear constants were obtained, taking into consideration the effects of neutron energy spectrum with position and flux depression in the presence of strong absorption such as burnable poison. Using these constants, the burnup characteristics of an assembly with a two-dimensional burnup diffusion equation were analyzed. A method of calculating a two-dimensional burnup equation in an assembly was formulated. By this method, it is possible to estimate an assembly with poison curtain. Calculation of the whole core burnup performance is relatively easy and the inventory of fertile materials such as uranium and plutonium can be obtained with reasonable accuracy. This method has been applied to certain reactors in Japan. The few experimental results obtained show good agreement with calculations. (auth)

18112 FEASIBILITY STUDY OF SHEATHED-THERMOCOUPLE-ELECTRODE FLOWMETER FOR LMFBR INDIVIDUAL SUBASSEMBLY. Kuwabara, Jun; Kato, Yoshio (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: 27-33(Jan 1971).

A unique proposal of sheathed-thermocouple-electrode flowmeter is presented. A pair of magnets and pole-pieces mounted inside a subassembly shell gives a transverse magnetic field in the outlet open channel. A pair of grounded type sheathed CA thermocouples is inserted into this field. The electromotive forces emerging from the four wires of the thermocouple pairs, by combination, should provide useful information on the outlet temperature, channel flow rate, sodium boiling, fission gas release resulting from pin failure, and cover gas entrainment. Essentially it requires no additional sacrifice on the part of reactor and fuel-handling designs compared with current outlet thermocouple installations. A preliminary feasibility study was made of this new type of flowmeter, and ample proof was obtained of its practicability. (11 references) (auth)

18113 DEVELOPMENT OF MAJOR COMPONENTS FOR FBR. THE DEVELOPMENT OF MECHANICAL FEATURES. Abe, Yasuhiro (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 16: No. 9, 10-14(Sep 1970). (In Japanese).

The Fast Breeder Reactor being developed in Japan is described. The reactor core, thermal bowing and seismic design, and holding-down of the fuel assemblies and flow-rate control in the reactor core are discussed. The reactor body, including the loop and pool types and upper reactor portions, is described. Merits and demerits of the two types are indicated. The hot-cell and the plug technique are explained with regard to the fuel exchange. Reactor components are presented. (Japan)

18114 OVERSEAS GENERAL TRENDS OF MULTI-PURPOSE HTR DEVELOPMENTS. Nozawa, Masao (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 16: No. 10, 6-9(Oct 1970). (In Japanese).

The high-temperature gas cooled reactor is most suitable for the multipurpose applications of a nuclear reactor; the fuel is generally a ceramic one, clad with graphite, and the coolant is helium gas, these combined providing the high temperature of coolant. Developments of the multi-purpose HTGRs, overseas and also in Japan, are described in the following. (1) Oversea trends of the development. Based on the results of a study team, the trends in West Germany OECD (Dragon project) and the United States are explained. (2) Technological problems. The problems to be encountered in raising the current 700°C–800°C to over 1,000°C in coolant are reviewed in fuel, piping, and heat exchanger. (3) Experimental, multi-purpose reactor envisaged by JAERI, with 35 MW(t), outlet helium temperature 1,000°C, and three coolant loops. (Japan)

18115 DEVELOPMENT OF MAJOR COMPONENTS FOR FBR. THE DEVELOPMENTAL PROBLEMS OF COMPONENTS. Miki, Ryohei (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 16: No. 9, 6-9(Sep 1970). (In Japanese).

Major components of the Fast Breeder Reactor being developed in Japan are explained. Some features of the prototype FBR are: Na-cooled and three loops; 750 MW(t); PuO_2–UO_2, and UO_2 (blanket); and controlled with B_4C. The following are described, indicating various problems encountered: reactor, including the vessel (loop type), shielding plug (plug type for fuel exchange) and control rod; cooling system, a steam generator (helical-coil or straight tubes), intermediate heat-exchanger, large pumps and valves; and the fuel exchange system, including a fuel exchanger, insertion and cask, and cask-transfer mechanism. (Japan)

18116 DESIGN OF A POWER PLANT WITH A PRESSURIZED WATER REACTOR. Yoshikawa, Hideo (Mitsubishi Atomic Power Industries, Inc., Tokyo). Nippon Kikai Gakkaishi; 73: 570-7(Apr 1970). (In Japanese).

The continuing advance of pressurized water reactor technology made feasible the design and construction of very large nuclear

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power plants, of which capital and operating costs have decreased corresponding to the increase in plant size. Such improved PWR technology was achieved by such factors as: demonstration of the inherent stability and mechanical integrity of very large PWR cores; and design improvement that permits lower hot channel factors, the uniform distribution of output in a core, and the attainment of maximum performance. One of the predominant features of the PWR is the chemical shimming for reactivity which prolongs fuel life, reduces the number of control rods required, improves core performance, and also allows the operator to take advantage of the future increase in burn up. Low fuel cost can be achieved by extracting more megawatt days of energy per metric ton of uranium. With the accumulation of experience in construction and operation, the design of PWR has come to the stage that an economical and reliable nuclear power station can be constructed. (Japan)

Kinetics and Dynamics

Refer also to abstracts 17862 and 18173.

18117 (CEA-CONF-1726) EL-600 SPACE-DEPENDENT KINETIC PROBLEMS. Goldstein, S. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 22p. (In French). (CONF-701019-4). Dep. NTIS (U. S. Sales Only).

From CREST Meeting on Reactivity Effects in Large Power Reactors, Ispra, Italy.

Two problems in spatial kinetics encountered and solved in the EL-600 project are presented. The first problem concerns the safety aspects associated with the rapidly occurring phenomena resulting from a break in the large primary piping: boiling in the channel (the increase in reactivity throughout the reactor core being essentially constant and the void coefficient of the coolant being positive); the dropping of the control rods after a given dead time. The second problem concerns slow xenon poisoning phenomena. (UK)

18118 EFFECT OF PHOTO-REACTIONS ON THE EFFECTIVE YIELD OF DELAYED NEUTRONS IN THE PRESSURE TUBE TYPE HEAVY WATER REACTOR. Kaneko, Yoshihiko (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: 34-40(Jan 1971).

A theoretical study with use made of the collision probability method was undertaken on the effect of photo-reactions upon the effective yield β of delayed neutrons in a pressure tube type heavy water reactor loaded with ^{235}U. It is concluded that the shielding effect of the reactor structural materials for the hard γ-rays emitted from fission products reduces the contribution of the photo-neutrons to β from the currently used value of 1.00×10^{-3} to 2.2×10^{-4}. (9 references) (auth)

18119 ANALYSIS OF DYNAMIC CHARACTERISTICS OF A PWR NUCLEAR PLANT. Obinata, Sumiko; Koyama, Shigeo; Wakamatsu, Seiji. Denki Shikensho Iho; 34: 619-38(1970). (In Japanese).

The dynamic characteristics of the Yankee-type PWR plants were analyzed from the standpoint of the power system through the use of a digital computer. The transient behavior of plant parameters such as the reactivity, the neutron density and the temperatures of fuel and coolant are given in the two cases of step and periodic changes of the power demand, with rod-control and without control. The effects of the neutron life time and the number of delayed neutrons, and the validity of the prompt jump approximation are also discussed in regard to plant parameters. It is confirmed that it is possible to improve the behavior of the plant parameters remarkably by using a suitable rod-control system. (9 references) (auth)

Control Systems

18120 DEVELOPMENT OF MAJOR COMPONENTS FOR FBR. THE DEVELOPMENT OF CONTROL EQUIPMENT. Hada, Mikio (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Genshiryoku Kogyo; 16: No. 9, 15-21(Sep 1970). (In Japanese).

The control of a fast breeder reactor plant is divided in the control of the reactor-core power (i.e. reactivity), and the overall control for the whole plant, including the three loops with intermediate and terminal (steam) heat exchangers. The following are described in connection with the Fast Breeder Reactor being developed in Japan: characteristics of the fast-reactor reactivity control, including neutron behavior, control procedure, past developments, and engineering; and instances of the fast-reactor control. (Japan)

Cooling Systems

18121 (ANL-6922) DESIGN, ANALYSIS, AND CONSTRUCTION OF EBR-II PRIMARY TANK AND ASSOCIATED STRUCTURES. Seidensticker, R. W. (Argonne National Lab., Ill.). Sep 1970. Contract W-31-109-eng-38. 99p. Dep. NTIS.

The entire EBR-II primary coolant system and fuel-handling system are submerged in about 80,000 gal of sodium at 700°F, all contained in a large double-walled vessel (primary tank). The design, fabrication, and erection of the primary tank and its support structure are described. Special features of the design peculiar to this system are emphasized, particularly the fabrication and erection of the several large machined weldments employed in the system. Design philosophy for the structural system is developed, and typical design calculations presented. The thermal deformations of the primary tank at elevated temperatures are treated theoretically. Elevated temperature tests performed both before and after filling the tank with sodium are described, and test results summarized. The thermal design of the primary tank is discussed. 11 references. (auth)

18122 (EURFNR-863) OPTIMIZATION OF REACTOR THERMAL DESIGN BY STATISTICAL HOT SPOT ANALYSIS. Amendola, A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Nov 1970. 22p. (KFK-1284; EUR-3682). Dep. NTIS.

Work performed under United States-Euratom Fast Reactor Exchange Program.

The influence of temperature and power flattening on the hot channel factor is examined for uniform slab and cylindrical cores. It is shown that, at constant hot channel probability, the maximum available power and maximum average coolant temperature do not coincide with the condition of complete flattening; this is due to the consequent increase in the overall hot channel factor. However the difference between optimum condition and complete flattening is small. This result is applied to the optimization of the distribution of the coolant flow rate among the several subassemblies of a sodium-cooled fast reactor. By a comparison between different design criteria, it is shown that, for given power distribution and inlet temperature, distributing the coolant in such a way, that the probability of hot spots is constant in each subassembly, results in a higher average coolant temperature at core outlet, that is in a better reactor efficiency. However the advantage of this criterion is in general small, it increases if the uncertainties are not constant along the core radius. (8 references) (auth)

18123 FLOW MEASURING DEVICE FOR SODIUM-COOLED REACTORS. Germer, John H. (to United States Atomic Energy Commission). U. S. Patent 3,549,494. 22 Dec 1970. Filed 8 Aug 1968.

An apparatus for measuring the coolant flow at the entrance of fuel bundles in a liquid sodium-cooled nuclear reactor is described. The apparatus works on the principle of a flow venturi transmitting a pressure signal to a differential manometer with electrical level sensors, and is constructed such that parts thereof requiring maintenance are readily accessible. (auth)

18124 VESSEL FOR A SODIUM-COOLED REACTOR. Germer, John H.; Boardman, Charles E. (to United States Atomic Energy Commission). U. S. Patent 3,548,931. 22 Dec 1970. Filed 30 Oct 1968.

A vessel construction or arrangement for a sodium-cooled nuclear reactor which includes a sealing arrangement permitting leakage between the inert cover gas of a hot sodium tank and an insulated outer vessel, and a system for circulating and cooling the inert gas to prevent migration of sodium vapor to the cold surfaces of the outer vessel are described. (auth)

18125 TURBULENT MIXING AND THE THERMAL DEFLECTION OF FUEL PINS: A PROCEDURE WITH APPLICATION TO THE LMFBR. Ginsberg, T. (Argonne National Lab., Ill.). Nucl. Eng. Design; 14: 191-7(Nov 1970).

A procedure for evaluating the influence of turbulent mixing on the thermal deflection of fuel pins is presented. The deflection of a single edge row fuel pin in a 19 pin liquid sodium cooled fuel subassembly is considered in a specific problem. HECTIC-III was used to do the thermal-hydraulic calculations; a relatively simple bowing model was chosen to simplify the thermal stress calculation. The uncertainties involved in the computation resulting from limitations of current technology are discussed. (12 references) (auth)

18126 NUCLEAR COMPARISON OF COOLANTS IN HEAVY WATER PRESSURE-TUBE REACTORS. Schludi, H. N. Atomkernenergie; 16: 225-9(1970).

Heavy water pressure tube reactors having reached the stage of power reactors or at least of power demonstration. Reactors use heavy water, CO_2 and boiling light water as coolant. These three coolant variants are briefly described and evaluated as far as their nuclear characteristics are concerned. The evaluation shows a superiority of the coolants with low neutron absorption, namely, D_2O and CO_2 for higher values of the ratio $N(D_2O)/N(U)$. (7 references) (auth)

18127 CONCRETE VESSEL TECHNOLOGY. Southwood, J. R. M. (Nuclear Power Group Ltd., Knutsford, Eng.). At. Energy Rev.; 8: 889-948(Dec 1970).

The prestressed pressure vessel has become the established choice for the primary containment of gas-cooled reactors. It is also being used as the secondary containment for water-reactor designs and is being considered for water-reactor primary containment. Its development since it was first used for the Marcoule reactors in France is reviewed. Although Marcoule was the first application of prestressed concrete for reactor containment, the technique was not generally used after that until the development of the Oldbury reactor in the United Kingdom where, for the first time, the integral concept was introduced. The concrete vessel has certain advantages with regard to safety, economy and development potential. Reactor development at the time the Oldbury reactor was being designed illustrates the transition point between steel vessels and concrete vessels. Not only does the concrete vessel offer economy but, in addition, it gives a greater integrity since gross failure is not conceivable and the stressing tendons can be inspected and replaced at any time. The massive structure also minimizes the chance of extensive damage. These factors, which are discussed, lead to the elimination of secondary containment for the more highly rated reactors which provides further cost saving. A number of reactor vessels completed or under construction are described. As many of the features are similar in principle, the Oldbury reactor was selected for detailed description to establish these principles since it represents a new generation in reactor-vessel design. Other designs can then be compared with Oldbury to indicate changes. The development of suitable liners for the inner face and new forms of insulation on this inner face are discussed as these represent the more difficult problems associated with concrete vessel technology. (66 references) (auth)

18128 PROBLEMS OF KEEPING CLEAN THE SODIUM COOLANT IN FAST REACTORS. Ullmann, H. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 13: 341-6 (Nov 1970) (In German).

The chemical properties of sodium require special arrangements for keeping the coolant clean. These arrangements consist of excluding sources of impurities, in purifying the sodium during operation, and permanent monitoring the content of impurities. The requirements of purity to be observed are based on the detrimental effects of the impurities. The state in the development of purifying techniques and devices is presented, the trends of evolution are evaluated. (8 references) (auth)

18129 EXPERIMENTAL INVESTIGATION ON VIBRATION OF A 19-ROD CLUSTER FUEL ELEMENT COOLED BY TWO PHASE (GAS + LIQUID) FLOWING MIXTURE. Cedolin, L.; Hassid, A.; Rossini, T. (CISE, Milan). Termotecnica (Milan); 24: 488-94(Nov 1970). (In Italian).

For the fuel element development of the CIRENE nuclear reactor a detailed investigation was undertaken on all channel vibrational characteristics. The power channel consists of a vertical pressure tube (10.61 cm ID) containing eight 19-rod closely spaced rod (2.0 cm OD) bundles. Each bundle is 50 cm long and simply rests over the lower one. The coolant conditions (~50 bar pressure) vary between a few °C subcooling at the entrance and ~25% (by weight) steam quality at the exit. The investigation was mainly carried out with a two-phase two-component mixture (simulating the behavior of steam-water mixture) flowing in an adiabatic out-of-pile circuit. The work mainly focused the following items: development of the appropriate instrumentation to detect vibrations of pressure tube and fuel element; systematic measurement of vibrations and effect of flow conditions. A detailed description of instrumentation and some experimental data obtained are presented. (auth)

18130 SOME ASPECTS OF BOILING NOISE DETECTION IN SODIUM REACTORS BY MEANS OF A MECHANICAL WAVEGUIDE. Woodward, B. (Guys Hospital Medical School, London); Stephens, R. W. B. Ultransonics; 9: 21-5(Jan 1971).

Some of the problems associated with the detection of boiling in a liquid-metal reactor are presented. A possible method of detecting the boiling lies in the use of a stainless steel waveguide as an acoustic transformer which vibrates in response to boiling noise signals. The design of a laboratory apparatus for simulatory experiments is discussed and results reported which were obtained using waveguides in the form of solid rods, tubes and wires, in a variety of configurations as well as for several materials. (auth) (UK)

18131 HIGH-TEMPERATURE AND HIGH-PRESSURE PIPING FOR NUCLEAR POWER REACTORS: THE DESIGN, AND ACCIDENT COUNTERMEASURES. Yoshikawa, Hideo (Mitsubishi Atomic Power Industries, Inc., Tokyo). Haikan Gijutsu; 12: 146-54(Mar 1970). (In Japanese).

High-temperature and high-pressure piping systems in light-water power reactors are described for design and accident countermeasures. The fundamental principles of design of the piping are explained from the standpoint of radiation protection. Descriptions include: design of the safety-countermeasure piping; valves in the high-temperature and high-pressure piping, including motor valve, manual valve and safety valve; valves at the penetrations through the reactor containment vessel; and the (liquid) waste treatment facilities. (Japan)

18132 DEVELOPMENT OF MAJOR COMPONENTS FOR FBR. THE DEVELOPMENT OF PUMP, PIPING, AND VALVE. Aoki, Naoji (Hitachi Ltd., Ibaraki, Japan). Genshiryoku Kogyo; 16: No. 9, 22-5(Sep 1970). (In Japanese).

In a Na-cooled fast breeder reactor plant, pumps play the role of circulating coolant in the two loops, and the piping and valves are main members constituting the coolant loops. The following are described in connection with the Fast Breeder Reactor being developed in Japan: characteristics of the pumps, piping and valves for a fast breeder reactor; pumps electromagnetic and (ordinary) mechanical pumps; piping; and valves. (Japan)

18133 DEVELOPMENT OF MAJOR COMPONENTS FOR FBR. THE DEVELOPMENT OF INTERMEDIATE HEAT EXCAHNGERS AND SODIUM HEAT STEAM GENERATORS. Nakai, Yasushi (Mitsubishi Atomic Power Industries, Inc., Tokyo). Genshiryoku Kogyo; 16: No. 9, 26-34(Sep 1970). (In Japanese).

The intermediate heat exchanger is used for sodium to sodium in the first and second loops, respectively, and a steam generator in the third loop, in a fast breeder reactor plant. The steam generator is the key point in success of this type of reactor plant. The following are described in connection with the Fast Breeder Reactor being developed in Japan: intermediate heat exchanger; and steam generator. (Japan)

18134 COOLING SYSTEM OF HTGCR. Muto, Yasushi (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 16: No. 10, 21-6(Oct 1970). (In Japanese).

In connection with the cooling system for HTGCRs, the following are described: HTGCR reactor vessel; primary cooling system of HTGCR; and the secondary cooling system of HTGCR. The applications of HTGCR are explained. (Japan)

Fuels

18135 (EUR-4477) NEUTRON STUDIES ON PLUTONIUM IN THERMAL REACTORS. Final Report. Bir, R.; Vidal, R.; Livolant, M.; (and others) (Commissariat a l'Energie Atomique, [Saclay] (France). Centre d'Etudes Nucleaires). Nov 1970. 233p. (In French). Dep. NTIS (U. S. Sales Only). EUR FF 33,40.

The survey of the work made since 1958 by the C.E.A. on plutonium-bearing fuels and fuel irradiated in nuclear power plants is reviewed. Methods used for fuel analyses are described: isotopic dilution method and its recent improvements, physical methods based on the counting of neutrons from the spontaneous fission of ^{240}Pu, or of alphas emitted by plutonium. An accuracy of about 0.4% has been achieved. Codes for cell computations have been developed. They use simultaneously a special space treatment (zones source method) and the secondary thermalization model (Cadilhac model). These time-saving codes are used for routine computations. For more refined calculations, an improved THERMOS code is used. Experimental studies on U–Pu alloys and on irradiated samples were made by replacement and oscillation techniques. Their interpretation has led to recommend values for constants of Pu-bearing fuels. (auth)

18136 (GA-9838) GAS-COOLED FAST BREEDER REACTOR. Quarterly Progress Report, November 1, 1969–January 31, 1970. (Gulf General Atomic, Inc., San Diego, Calif.). 27 Feb 1970. Contract AT(04-3)-167. 50p. Dep. NTIS.

NEUTRONS, FAST — effects on microstructure of stainless steel

PLUTONIUM OXIDES PuO_2 — PuO_2–UO_2, radiation effects on gas cooled fast breeder reactor fuels of

REACTOR FUEL ELEMENTS— radiation testing of plutonium oxide (PuO_2)–uranium oxide (UO_2), for gas cooled fast breeder reactors
REACTORS, BREEDER— core development for gas cooled, November 1969 to February 1970
REACTORS, FAST— core development for gas cooled, November 1969 to February 1970
REACTORS, GAS COOLED— core development for fast breeder, November 1969 to February 1970
STAINLESS STEEL— radiation effects on microstructure of, fast neutron
URANIUM OXIDES UO_2— PuO_2–UO_2, radiation effects on gas cooled fast breeder reactor fuels of (H.D.R.)

18137 (GEAP-10028-36) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Thirty-Sixth Quarterly Report, August-October 1970. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation) Dec 1970. Contract AT(04-3)-189. 165p. Dep. NTIS.

FAST CERAMIC REACTOR— fuel element for, development during August to October 1970
—core for, design and kinetics analysis of
—safety of, transient overpower and coolant loss effects on
LIQUID METAL FAST BREEDER REACTOR— fuel elements for, development of stainless steel clad plutonium oxide (PuO_2)–uranium oxide (UO_2)
NEUTRONS, FAST— effects on mechanical properties and swelling of stainless steel fuel element cladding, (E)
—effects on structure changes in plutonium oxide (PuO_2)–uranium oxide–uranium oxide (UO_2) fuels, (E)
PLUTONIUM OXIDES PuO_2— PuO_2–UO_2, radiation effects testing of fuels of
—PuO_2–UO_2, properties of fuels of, mechanical, physical, and thermal, (E)
REACTOR FUEL ELEMENTS— performance of defective mixed oxide, in flowing sodium, (E)
—cladding for mixed oxide fast, development and testing of stainless steel
—radiation effects testing of mixed oxide fast
STAINLESS STEEL— radiation effects on swelling and mechanical properties of Type 304 and Type 316, fast neutron, (E)
URANIUM OXIDES UO_2— PuO_2–UO_2, radiation effects testing of fuels of
—PuO_2–UO_2, properties of fuels of, mechanical, physical, and thermal, (E) (D.C.C.)

18138 (ORNL-TM-3137) ENGINEERING DEVELOPMENT STUDIES FOR MOLTEN-SALT BREEDER REACTOR PROCESSING NO. 2. McNeese, L. E. (Oak Ridge National Lab., Tenn.). Feb 1971. Contract W-7405-eng-26. 102p. Dep. NTIS.

A molten-salt breeder reactor (MSBR) will be fueled with a molten fluoride mixture that will circulate through the blanket and core regions of the reactor and through the primary heat exchanger. Processing methods for use in a close-coupled facility for removing fission products, corrosion products, and fissile materials from the molten fluoride mixture are described. Several operations associated with MSBR processing are discussed. Topics described include: a proposed reductive-extraction flow sheet for a single-fluid MSBR; material-balance calculations that show the effects of the removal time for zirconium, alkali metals and alkaline earths, europium, and protactinium on reactor performance and that indicate the magnitudes of the heat generation and mass flows associated with the reactor off-gas; calculated results showing the steady-state performance of a protactinium isolation system; an evaluation of the use of the protactinium isolation system to limit the uranium concentration in the blanket of a single-fluid MSBR; calculations to predict the steady-state performance of a rare-earth removal system based on reductive extraction; preliminary testing of the semicontinuous reductive-extraction facility; experiments related to the development of electrolytic cells for use with molten salt and bismuth; and installation of equipment at the MSRE for demonstrating low-pressure distillation of molten salt, using irradiated MSRE fuel carrier salt. 5 references. (auth)

18139 (WCAP-7379(Vol.2)) PERFORMANCE OF ZIRCALOY CLAD FUEL RODS DURING A SIMULATED LOSS-OF-COOLANT ACCIDENT: SINGLE ROD TESTS. VOLUME II. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). 15 Sep 1969. Contract AT(30-1)-3017. 21p. Dep. CFSTI.

Methods of testing and results of testing irradiated Zircaloy tubes are described. The test samples were taken from the spent fuel of the Yankee power plant. The tube dimensions were nominally eight inches long with a 0.362-inch OD and a 0.022-inch wall. Twenty tests were performed on these irradiated tubes; sixteen were tested to failure at various internal pressure and heating rate conditions (these tests were run with Al_2O_3 pellets and a plenum assembly to simulate fuel pin conditions) and four were quench tests run to assess tube stability. An additional twelve tests were run on unirradiated tubes of 0.422-inch OD and 0.027-inch wall thickness (using Zircaloy tubes supplied by the Oak Ridge National Laboratory). Details of the test conditions and the test rigs are given. (auth)

18140 (WHAN-SA-7) EVALUATION OF PuO_2 HOMOGENEITY IN PuO_2–UO_2 FAST REACTOR FUEL BY SCANNING ELECTRON MICROPROBE. Stranik, D. A.; Powers, H. G.; Last, G. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab. WADCO Corp., Richland, Wash.). [1970]. Contracts AT(45-1)-1830; AT-(45-1)-2170. 13p. (CONF-701102-17). Dep. NTIS.

From Meeting of the American Nuclear Society, Washington, D. C.

The theory and the experimental data for measuring homogeneity of fuel pellets based on the functional performance requirements of the fuel in the reactor are presented. The functional performance is the thermal response of the mixed oxide fuel under transient conditions. Two tests were designed in order to derive the homogeneity model. The first test was designed to determine quantitatively by use of the scanning electron microprobe PuO_2 concentrations, sizes of PuO_2 enriched or depleted zones and the frequency of occurrence. The pellets were irradiation test pellets taken from 23 sintering batches. From the data, a theoretical homogeneity model was established based on heat generation rates and energy disposition within the UO_2–PuO_2 pellets. A second test was designed to verify the model and to determine the homogeneity of several pellets with a wide range of homogeneities based on alpha-autoradiographs. 5 references. (auth)

18141 FUEL RODS WITH INTERNAL FINS. Ihle, P.; Rust, K. (Kernforschungszentrum, Karlsruhe, Ger.). Atomkernenergie; 16: 231-2(1970). (In German).

Fuel rods are equipped with internal fins or cams to increase the rod power and, hence, reduce the fissile material inventory. Such an internal fin geometry increases the thermal conductivity of the outer fuel zone considerably. Calculations have shown this measure to increase the rod power of oxide fuel rods by 25 to 50% relative to the power of fuel rods with a smooth inner surface. (auth)

18142 LMFBR FUEL ROD DESIGN LIMITS AND TRANSIENT SURVIVAL CRITERIA. Carelli, M. D.; Anderson, C. A. Jr.; Markley, R. A. (Westinghouse Electric Corp., Madison, Pa.). Atomwirt., Atomtech.; 16: 84-5(Feb 1971).

The results of an evaluation of the operational and off-normal transients occurring during fuel element lifetimes, their frequency, their thermal and mechanical effect on cladding and fuel, and the rod failure limits are summarized. The effects of expected characteristics of large LMFBR plants on maximum allowable cladding and fuel temperatures and the tolerable amount of molten fuel were calculated. (H.D.R.)

18143 OPERATIONAL PROSPECTS OF A PLUTONIUM CYCLE IN THERMAL REACTORS. Tweedy, John Noel (Scotland Electricity Board, Glasgow); Castelli, Gianfranco. At. Strom; 16: 147-8(Oct 1970). (In German).

The operational prospects of the use of plutonium instead of U-235 enriched fuel in present-generation thermal reactors are analyzed. Economic factors are not discussed. (auth)

18144 FUEL AND CORE STRUCTURE OF HTGCR. Miyamoto, Yoshiaki (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 16: No. 10, 17-20(Oct 1970). (In Japanese).

The fuel for a HTGCR consists of Py C coated fuel particles embedded in the graphite matrix, constituting a fuel element. The following are explained. (1) Coated fuel particles, dealing with the forms of particle, the production, and characteristics. The fuel particles, 0.2–1.1 mm in diameter, have coatings to retain FP gas. To produce them, powder metallurgical and sol-gel methods are available. Then, carbide and oxide fuels are compared; and, the damage of particles and FP release are treated. (2) Fuel elements. Based on the loose, strong and intermediate bondings of fuel particles in the graphite matrix, the fuel elements in rod, block, sphere, etc., are described. (3) Structure of the HTGCRs. The cases of DRAGON, Peach Bottom, AVR, and Fort St. Vrain reactors are explained. (Japan)

Auxiliary and Emergency Systems

Refer also to a *07, and 18183.*

18145 CONDENSATE TREATMENT CONSIDERATIONS FOR BOILING-WATER REACTOR SYSTEMS. Ryan, Leo F.; Limon, L. (Graver Water Conditioning Co., Union, N. J.). Proc. Amer. Power Conf.; 32: 757-70(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The evaluation factors affecting the choice of condensate treatment systems are discussed. Economic factors, the effects of radioactive waste disposal, and the effects of operating with condenser leaks are examined. (7 references) (H.D.R.)

18146 SYSTEM FOR DETECTING SODIUM BOILING IN A REACTOR. Pluta, Philip R. (to United States Atomic Energy Commission). U. S. Patent 3,549,489. 22 Dec 1970. Filed 22 Oct 1968.

A system for detecting and controlling sodium boiling in a sodium cooled nuclear reactor is described. Frequency analysis of the neutron flux signal from in-core or out-of-core detectors indicates the onset of incipient sodium boiling before there is any noticeable net power change which would otherwise require corrective action to be taken. Since incipient sodium boiling has a characteristic frequency associated with the collapse of the sodium bubbles, the collapse rate or boiling frequency of the bubbles is communicated to the flux noise as a coherent signal whose amplitude is determined by filtering means. This signal is then transmitted through appropriate electronics for actuating the control rod system of the reactor for controlling the reactivity thereof, thereby providing a reactor safeguard system. (auth)

18147 SEPARATION OF RADIOIODINE FROM THE EXHAUST AIR OF NUCLEAR REACTOR FACILITIES. Strauss, H.-J.; Winter, K. (Concordia Elektrizitaets AG, Dortmund, Ger.). Kerntechnik; 12: 491-5(Nov 1970). (In German and English).

Filters against radioactive iodine-isotopes in nuclear power plants are the last barrier which prevents escaping of these isotopes (which may be set free in case of a failure) into the free atmosphere. The iodine-removal by adsorption or chemisorption is reduced by the formation of organic iodine components with low bp and high vapor pressure (e.g., methyl iodide), especially at high humidity. Due to the application of an isotope exchanging process (still unusual in the air cleaning techniques), it is possible to decisively improve the efficiency of these filters (which are parts of the MCA filter) against methyl iodide under extremely high humidity. The underlying principles of this process are described and two examples for the application of such filters for cleaning the exhausted air of a "ring-slot-system" of a reactor are given. 8 references. (auth)

Operation and Economics

18148 (ORNL-4622, pp 1-6) MOLTEN-SALT REACTOR EXPERIMENT. (Oak Ridge National Lab., Tenn.).

From Molten-Salt Reactor Program.

MOLTEN SALT REACTOR EXPERIMENT—operations during March to September 1970
—heat exchanger for, deposition of fission product metals on surfaces of, (E/T)
—fuel salt for, effects of temperature on fluorine recombination with, (E)
—fuel salt for, effects of time after shutdown on fission product energy sources in, (T)
—pumps for, testing of (H.D.R.)

18149 POWER REACTORS FOR THE FUTURE: AN EVALUATION. Carlsmith, R. S.; Lane, J. A. (Oak Ridge National Lab., Tenn.). Proc. Amer. Power Conf.; 32: 98-104(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

An overall review of the U. S. nuclear power program is summarized. Performance characteristics for each reactor type were developed to give fuel usage and separative work requirements. Estimates were prepared of the capital, operating, fuel, and total power costs for each reactor type. (16 references) (H.D.R.)

18150 INTEGRATED MODEL FOR TIME-DEPENDENT AND EQUILIBRIUM FUEL COMPOSITIONS IN FAST BREEDER REACTORS. Terrell, Charles William. Lafayette, Ind.; Purdue Univ. (1970). 135p. University Microfilms Order No. 70-18,751.

Thesis.

A mathematical model is developed to determine the isotropic composition of a fast-reactor fuel as a function of time. The model then is used to investigate the effect of several parameters on the equilibrium plutonium composition, the time dependence of the core composition, and the composition of discharge and feed, as well as the surplus plutonium resulting from breeding. Closed recycle with joint reprocessing of core and blanket fuel was assumed for a 25-year reactor operating lifetime when the model was applied to a reference reactor. The model incorporates both internal and external fuel management and finite burnup and accounts for reprocessing and fabrication losses and total out-of-pile time. Loading of fresh fuel is treated as a continuous feed current and unloading of spent fuel as a continuous removal current. A 1000 MW(e), liquid-metal-cooled, mixed-oxide reference reactor was defined; and the equilibrium plutonium composition was calculated to be 77.50% ^{239}Pu, 19.00% ^{240}Pu, 3.11% ^{241}Pu, and 0.39% ^{242}Pu. Application of the model to the reference reactor indicates that for a closed fuel cycle, the time required to reach equilibrium in the fuel composition depends upon the start-up composition, residence time in the external fuel cycle, amount of burnup in core and blankets, and reactor design. In contrast, it is found that the equilibrium plutonium composition itself depends only on core and blanket burnups and reactor design characteristics. The model also was employed to investigate effects of out-of-pile time and losses, finite burnup, scatter loading fuel cycle parameters and start-up composition on the amount and composition of surplus plutonium. The total quantity of surplus plutonium produced over the operating lifetime was shown to be significantly dependent on the start-up composition. (TSS) (Diss. Abstr. Int., B)

18151 REAL-TIME SIMULATION OF CORE PERFORMANCE CALCULATION FOR BWR POWER PLANT. Miyagaki, H. (Hitachi Ltd., Kawasaki, Japan). Genshiryoku Kogyo; 16: No. 9, 42-6(Sep 1970). (In Japanese).

The monitoring system, which is important for the economical and reliable operation of a BWR power plant, was developed and tested by real-time simulation. The program system comprises the periodic program ich starts calculation by the periodical control with a digital c puter, and is composed of hourly, daily and monthly programs, and the on-demand program, which is started by an operator. The major calculations with the hourly program are described. The daily and the monthly programs calculate the average or the integration of hourly data. The function of on-demand program is discussed. For simulation, the reactor plant simulator of a 460 MW BWR composed of 2 analog computers, in-core monitor signal simulator, the reactor control panel simulator composed of control rod selection switch, LRPM indicator etc., were used. Process computer system comprises a digital computer, a process input-output device, and peripheral units. The peripheral units comprise an operator console, a console input-output device, a log typer and the CRT color display unit to display graphs and alphanumeric letters with seven colors. (Japan)

18152 OPTIMAL REACTOR STRATEGY FOR MINIMIZING NATURAL URANIUM REQUIREMENT. I. SYSTEM MODEL AND COMPUTATIONAL ASPECTS. Shinohara, Yoshikuni; Yasukawa, Shigeru; Shimazaki, Junya (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 7: 615-22(Dec 1970).

An optimization problem of nuclear power system economics is formulated and solved numerically with the application of linear programming technique. The problem treated here is to determine the optimal long-range reactor strategy that minimizes the total requirement of natural uranium under a restriction imposed on the quantity of excess plutonium. The optimization model and the problem formulation as a linear programming problem are described, accompanied by some examples of numerical solution. 10 references. (auth)

Safety and Siting

Refer also to abstract 15573.

18153 (AHSB(S)R-189) EFFECT OF DELAYED BUBBLE GROWTH ON THE DEPRESSURISATION OF VESSELS CONTAINING HIGH TEMPERATURE WATER. Hunt, D. L. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). Nov 1970. 22p. Dep. NTIS (U. S. Sales Only).

A method has been developed for calculating bubble growth in a rapidly depressurizing vessel initially filled with water and steam at saturation temperature. The theory is based on convective heat transfer to moving bubbles and predicts the correct trends in early stages of blowdown. The theory implies restrictions in the use of models to represent full-scale blowdown. 7 references. (auth)

18154 (ANL-7657) SAFETY PROBLEMS OF LIQUID-METAL-COOLED FAST BREEDER REACTORS. Kelber, C. N.;

XUM

Judd, A. M.; Cinelli, G. Jr.; (and others) (Argonne National Lab., Ill.). Feb 1970. Contract W-31-109-eng-38. 216p. Dep. NTIS.

The safety problems related to the design of cores for liquid-metal-cooled fast breeder reactors are reviewed. A phenomenological representation is related to potential accidents, and this representation is used to describe the program of work needed to develop adequate design principles. Some of the program requires massive in-pile installations for execution, and some is typical of work carried out in many university and industrial laboratories. 308 references. (auth)

18155 (BMI–1897) EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress Report, October–December 1970. Carbiener, Wayne A.; Ritzman, Robert L. (Battelle Memorial Inst., Columbus, Ohio). Jan 1971. Contract W-7405-eng-92. 32p. Dep. NTIS.

The analytical description of the course and consequences of a nuclear-reactor accident is essential to the continued development of commercial atomic power. Such descriptions form the basis for estimating the degree of safety embodied in the design and construction of every nuclear power plant. They are also of major significance in fixing the cost of electricity produced by a specific power plant because they assist in defining both the extent of engineered safety features and containment inherent in the plant design and the siting requirements. To obtain maximum use of the data being developed in a number of widely scattered and diverse programs conducted within the nuclear industry as well as relevant programs from other technologies, it is necessary to evaluate them in terms of their applicability to the ultimate prediction of the space-time distribution of radioactive material following a nuclear-reactor accident. Such an evaluation will serve three purposes, each important to the safe and orderly development of the nuclear-power industry: Expose inadequacies of existing data and consequently show where data are needed; serve to refine the techniques of mathematical analysis as applied to this problem; and provide more accurate descriptions of the course and consequences of nuclear accidents, allowing more efficient use of precautionary measures. To accomplish the task, it is necessary to combine pertinent methods of analytical description with the scientific and engineering data available as input for such techniques. This study is restricted to pressurized-water and boiling-water nuclear steam supply systems, in which the limiting postulated accident considered for safety analyses is the loss-of-coolant or "blowdown" situation. 27 references. (auth)

18156 (ORO–3822-7) STRUCTURE–FOUNDATION INTERACTION OF NUCLEAR POWER PLANTS: PHASE I FINAL REPORT. Scavuzzo, R. J. (Toledo Univ., Ohio. Research Foundation). Dec 1970. Contract AT(40-1)-3822. 53p. Dep. NTIS.

The extent to which large reactor structures interact with free-field seismic ground motion so as to alter the base motion from free-field values is analyzed. The significance of soil-structure interaction including rocking effects and consequent response spectra for a range of relatively idealized simulations of the structure, the foundation conditions and the input seismic wave form is determined. A finite element stress wave propagation program, SLAM, was employed at IITRI to study interaction effects. Results of these studies showed that interaction effects are often very significant and should be considered in the seismic design of nuclear power plants. The significance of interaction effects on dynamic loads caused by earthquakes depends upon the soil stiffness, the structure weight and modal properties, and the frequency characteristics of the input wave. 12 references. (auth)

18157 (WHAN-SA–43) APPROACHES TO REACTOR SAFETY. Hofmann, P. L.; Peterson, R. E.; Simpson, D. E. (WADCO Corp., Richland, Wash.). Oct 1970. Contract AT(45-1)-2170. 35p. (CONF-701035–2). Dep. NTIS.

From Meeting on Education and Research in the Nuclear Fuel Cycle, Norman, Okla.

The two basic approaches to reactor safety for water cooled reactors are: (1) reliance on accident prevention features and (2) reliance on consequence limiting features. These approaches are summarized and compared with the similar procedures used to treat liquid-metal-cooled fast breeder reactor safety questions. 12 references. (H.D.R.)

18158 LMFBR SAFETY. Dieckamp, H. M.; Ash, E. B.; Sevy, R. H. (Atomics International, Canoga Park, Calif.). Proc. Amer. Power Conf.; 32: 246–59(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

The basic safety-related features of liquid-metal-cooled fast-breeder reactors (LMFBR) are compared with those of light-water reactors. The safety differences are emphasized and safety design options of LMFBR plants are discussed. (H.D.R.)

18159 PROBLEMS CONCERNING SITES FOR NUCLEAR POWER STATIONS. Ailleret, Pierre. At. Strom; 16: 149–52 (Oct 1970). (In German).

The limitations extending to the sites of different types of thermal power station (conventional steam power stations, nuclear power stations with light-water reactors, nuclear power stations with breeder reactors) are described, as related to the heating of rivers. (auth)

18160 STRUCTURE-FOUNDATION INTERACTION OF A NUCLEAR POWER PLANT WITH A SEISMIC DISTURBANCE. Miller, C. A.; Costantino, C. J. (City Coll., New York). Contract W-7405-eng-26. Nucl. Eng. Design; 14: 332-42(Nov 1970).

Structure-foundation interaction effects were investigated to determine their influence on the dynamic response of a nuclear power plant to a seismic disturbance. The horizontal, vertical and rotational motion history of the facility is determined by means of a computer program, termed the SIM (Structure-In-Medium) code, which incorporates interaction effects by means of an approximate interaction law. The facility studied is the BONUS plant and the seismic disturbance applied to the site is the 1957 Golden Gate earthquake record. The response of the center of gravity of the BONUS facility was found to be less than that of the free-field disturbance, with peak acceleration attenuation varying inversely as soil stiffness. The rotational motion of the facility, however, was found to have a major influence on the motion of points far removed from the center of gravity. At these locations, the motion in the facility can be more severe than the free-field disturbance. 16 references. (auth)

18161 INITIAL SIZE DISTRIBUTIONS OF AEROSOLS. Lindauer, George C.; Castleman, A. W. Jr. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 43: 212-17(Feb 1971).

The use of digital computer programs to determine the size distribution of an aerosol as a function of time requires knowledge of the initial size distribution. The results of an analytical investigation made to determine whether an aerosol produced as an instantaneous source approaches a self-preserving shape are presented. For high number density aerosols, calculations indicate that the initial size distribution rapidly approaches a self-preserving shape which can be represented by a log-normal distribution with a standard geometric deviation between 1.34 and 1.40. This log-normal distribution is utilized to calculate a pseudo-initial particle size distribution for use as the initial condition in digital computer programs. (auth)

18162 CONTROL AND SAFETY ASPECTS OF HTGCR. Shinoda, W. (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 16: No. 10, 27-32(Oct 1970). (In Japanese).

Reviewing the control and safety of HTGCRs, the following are described. (1) Control and safety characteristics of HTGCRs. The characteristics common in the types of HTGCR are indicated in reactor physics, helium coolant, fuel and materials, high-temperature operation, FPs, PCRV, chemical reactions at an accident, etc. (2) Control of the HTGCR plant systems. The two cases are dealt with, viz. an indirect-cycle, steam turbine and a direct-cycle, gas turbine. (3) Release and movement of FPs. It is essential to minimize FPs release; FP generation in the fuel, the release into the primary coolant system, and then the settlement in the system. (4) Accidents in the HTGCR, including reactivity, sub-header rupture in the secondary coolant system, the rupture of a helium-purification system and a pressure reduction in the primary coolant system. (5) Safety countermeasures, viz. scrams, suspension of the primary-coolant system operation, PCRV, etc. (6) Control and safety of a multi-purpose reactor system. (Japan)

18163 STUDIES FOR SAFETY ANALYSIS OF LOSS-OF-COOLANT ACCIDENTS IN LIGHT-WATER POWER REACTORS. Fujie, Hideo; Yamanouchi, Atsuo; Sagawa, Norihiko; Ogasawara, Hideo (Hitachi Ltd., Ibaraki, Japan). Hitachi Hyoron; 52: 361-7(Apr 1970). (In Japanese).

The radioactive material released from the container vessel by a light-water power reactor accident was analyzed. As the Maximum Credible Accident, the loss-of-coolant accident was considered. The core spray cooling effect, coolant flow-out velocity (including the study of the critical flow), condensation heat transfer in the container vessel, and spray cooling effect in container were examined. Model experiments and theoretical computations were compared. The relations of heat flux to wall-temperature and heater wall temperature to time in the core spray cooling effect experiment were in good agreement with the theoretically computed results. The allowance for safety against a radioactivity accident was concluded to be sufficient. (Japan)

Power Conversion Systems

Refer also to abstract 18133.

18164 GAS TURBINES FOR SUPERHEAT IN A NUCLEAR POWER PLANT. Buscemi, V. P.; Hanton, C. E. (Westinghouse Electric Corp., Pittsburgh). Proc. Amer. Power Conf.; 32: 404-12(1970).

From 32nd Annual Meeting of American Power Conference, Chicago, Ill. See CONF-700426.

Combined-cycle technology, interlocking the steam and gas turbines, is surveyed. In nuclear power plants this concept also involves the addition of superheat to the primary steam supply. The combined-cycle concept is applied to a reference study, and performance and evaluation factors are discussed. (H.D.R.)

18165 SKODA STEAM TURBINES FOR NUCLEAR POWER STATIONS. Drahy, J. (SKODA Works, Plzen, Czech.). Jad. Energ.; 16: 361-6(Nov 1970). (In Czech).

The possibilities of draining of the through-flow part of the nuclear power station turbine with respect to the use of hollow guide blades having exhausting slots near the trailing edge are summarized. The active and passive methods of blade protection against erosion in wet steam are combined. The use of titanium alloys for blades is examined, the main problem being the protection against erosion. Further, particularities of turbines for nuclear power stations with gas cooled and water cooled reactors are enumerated. A 226 MW saturated steam turbine is being constructed. The so-called building-block system with limited number of LP-parts and end stages has been applied utilizing the experience with conventional turbines to nuclear power stations. In the case of 300 to 400 MW saturated steam turbines, a half turbine speed, i.e., 1500 liter/min, must be used. 11 references. (auth)

Research and Test Reactors

Refer also to abstracts 15918, 15930, and 18098.

18166 (ANL-7687) CODE FOR CALCULATING EFFLUENT AIR TEMPERATURES FROM A SAND FILTER. Rusch, G. K. (Argonne National Lab., Ill.). Nov 1970. Contract W-31-109-eng-38. 35p. Dep. NTIS.

A code that can be used to calculate the quantity of heat transferred to the sand and gravel comprising a ZPR-6 or -9 type sand filter and the temperature of the effluent air is described. A detailed listing of the code, a glossary of code terms, code input requirements, and code output are included. 3 references. (auth)

18167 (ANL-7708) SPECIFICATION AND PROCUREMENT OF CP-5 FUEL TUBES. Shuck, A. B.; Haugen, J. C. (Argonne National Lab., Ill.); Isserow, S.; Huber, R. F. (Whittaker Corp., West Concord, Mass. Nuclear Metals Div.). Aug 1970. Contract W-31-109-eng-38. 61p. Dep. NTIS.

Fuel assemblies for the Argonne National Laboratory Research Reactor CP-5 consist of concentrically nested, Al-clad, Al–U alloy fuel tubes. The fuel is prepared by dissolving fully enriched U in molten Al and casting hollow cylindrical billets. The billets are extruded as tubes from which cylindrical cores are machined. These are clad inside and outside in sealed Al jackets, which are bonded to the cores by coextrusion. The resulting Al-clad fuel tubes are radiographed, cut to length, blister-tested, cleaned, inspected, and sent to Argonne National Laboratory for construction of CP-5 fuel assemblies. Data from manufacture and inspection of 37 sets of the fuel tubes were evaluated, and a detailed procurement specification was prepared for future procurement of the tubular elements. (auth)

18168 (ANL-7752) MELTDOWN ANALYSIS OF VARIOUS EBR-II CORE CONFIGURATIONS USING THE MELT-II CODE. Golden, G. H.; Shum, R. H. (Argonne National Lab., Ill.). Nov 1970. Contract W-31-109-eng-38. 29p. Dep. NTIS.

Effects of unbounded input-reactivity ramps on three types of EBR-II core configurations were studied with the MELT-II code. One core contained only metal fuel and was similar to the wet-critical configuration; a second was a hypothetical mixed-oxide configuration; and a third contained both fuels in amounts typical of a recent irradiation configuration of the reactor. Feedback reactivity was assumed to be due to axial expansion of fuel, and, after melting, to gravity-induced fuel collapse. Collapse was taken to begin at a given point in the reactor when one of four specified input temperatures was exceeded; these temperatures were related to the fuel and cladding melting points or eutectic temperature and the normal boiling point of the coolant. The resulting model for noncoherent collapse resulted in much smaller collapse reactivity rates than those predicted earlier by use of a model for simple, coherent collapse. Also, the metal-fuel core would approach a disassembly condition only for input-reactivity ramps of about $20/sec or greater; the oxide-fuel core would approach disassembly for input ramps as low as $1/sec; and the mixed-fuel core would behave like the metal-fuel core. The results indicate that the EBR-II core should always have some metal fuel to protect it from rapid disassembly. 17 references. (auth)

18169 (BNWL-1395) PRELIMINARY ANALYSES FOR FFTF HEAT TRANSPORT CONTROL SYSTEMS. Harvey, R. A.; Hunt, S. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sep 1970. Contract AT(45-1)-1830. 172p. Dep. NTIS.

A study was conducted to determine the effect of the Fast Flux Test Facility main heat transport control system on the plant behavior. A high-speed simulation of the facility was used. The study was conducted to gather data concerning plant stability, characteristics of several control configurations, and effects of various operating conditions. Transient responses and frequency analysis were used to determine the controlled plant behavior. The data gathered and some conclusions on the basis of the data are presented. (auth)

18170 (BNWL-1481) CRITICAL EXPERIMENTS IN AN MTR MOCKUP USING PHOENIX FUEL. Davis, E. C. Jr.; Smith, R. I.; Williams, L. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 90p. Dep. NTIS.

Utilization of ^{240}Pu as a convertible poison in plutonium-fueled systems is being studied under the Phoenix Fuel Reactor Program at Pacific Northwest Laboratory. An extensive experimental program using Phoenix fuel in a critical mockup of the Materials Testing Reactor (MTR) has been completed in the Plutonium Recycle Critical Facility. The PRCF-Phoenix mock-up duplicated as closely as possible the physical configuration of the MTR in order to determine the characteristics of such a core. The experiments performed in this mock-up provided information on the reactivity effects and power distributions to be expected of an MTR-Phoenix fuel core prior to the loading of a full core in the MTR. These data have provided an excellent test of the computational methods currently being applied to Phoenix Fuel cores. The results of the PRCF experiments are presented. 30 references. (auth)

18171 (CEA-N-1386) EXPERIMENTAL STUDY OF THE ATTENUATION OF NEUTRONS IN VARIOUS PROTECTIVE MATERIALS USING THE NAIADE I DEVICE OF THE ZOE REACTOR. Lott, Michel; Pepin, Pierre; Bourdet, Lucien; Cabaret, Guy; Capsie, Jacques; Dubor, Monique; Hot, Michel; Goulet, Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec 1970. 100p. (In French). Dep. NTIS (U. S. Sales Only).

The principal experiments made in the Naiade I device installed in the Zoe reactor are described. The propagation of neutrons in a great number of protective materials (iron, graphite, concrete, and water) was studied. The appropriate constants, in particular for the application to the theory of one or two group diffusion, were determined. 12 references. (auth)

18172 (DOCKET-50231-70) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. License No. DR-15; Technical Specifications Change No. 2. (Division of Reactor Licensing (AEC), Washington, D. C.). 12 Feb 1971. 39p. Dep. NTIS.

Revised technical specifications are presented concerning: safety limits for operating at 20 MW(t) with guinea pig fuel rods; operations with fuel clad failures; and surveillance requirements for failed fuel cladding. (D.C.C.)

18173 (EURFNR-861) FAST REACTOR LATTICE EXPERIMENT FOR INVESTIGATION OF k_∞ AND REACTION RATE RATIOS IN SNEAK, ASSEMBLY 5. Boehnel, K.; Meister, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Jun 1970. 56p. (KFK-1176; CONF-690654-1). Dep. NTIS (U. S. Sales Only).

From Meeting of Specialists on the Value of Plutonium Alpha, Winfrith, England.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

A fast reactor lattice experiment was carried out in the zero-power facility SNEAK, assembly 5, to determine k_∞ and reaction rate ratios. The assembly consists of a central test zone surrounded by axial and radial driver regions. The test zone contains platelets of mixed PuO_2–UO_2, depleted and natural U metal, and graphite as a moderating material. Its composition was chosen to render a k_∞ close to unity. The k_∞-values of systems with different $C/^{235}U$-ratio were determined by voiding a central region of the test zone and measuring the associated reactivity

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change. Fission rates of ^{235}U and ^{238}U inside the lattice cell were measured with solid state track detectors, the ^{238}U-capture rate by activation of depleted uranium foils and subsequent γ-x-ray coincidence counting. The experimental results are compared with 26-group calculations using different methods and cross section sets. 19 references. (auth)

18174 (IS–2300) CERAMIC ENGINEERING, CHEMICAL ENGINEERING, CHEMISTRY, MATHEMATICS AND COMPUTER SCIENCE, METALLURGY, PHYSICS, AND REACTOR DIVISIONS ANNUAL SUMMARY RESEARCH REPORT, JULY 1969–JUNE 1970. (Ames Lab., Iowa). Nov 1970. Contract W-7405-eng-82. 273p. Dep. NTIS.

Research and development programs undertaken by the Ames Laboratory during July 1969 to June 1970 are reviewed. Research divisions presented include: ceramic engineering; chemical engineering; chemistry; mathematics and computer; metallurgy; physics; and reactor. Separate abstracts are included for each of the 7 sections presented. (D.C.C.)

For abstracts of individual sections see: 15561, 15562, 16398, 16569, 17326, 17403, and 18175.

18175 (IS–2300, pp 253–73) REACTOR DIVISION. Crudele, J. S.; Gurganus, E. K.; Lessly, R. E.; (and others) (Ames Lab., Iowa).

From Ceramic Engineering, Chemical Engineering, Chemistry, Mathematics and Computer Science, Metallurgy, Physics, and Reactor Divisions annual summary research report, July 1969–June 1970.

Design modifications and additions to the Ames Research Reactor are described. Fuel cycle management procedures and schedule are presented. Experimental programs in the reactor are reviewed. Operations during July 1969 to June 1970 are described. (D.C.C.)

18176 (ORNL–4502) FISSION PRODUCT TRANSPORT AND BEHAVIOR IN THE STAINLESS STEEL LINED CONTAINMENT RESEARCH INSTALLATION (CRI). Parker, G. W.; Creek, G. E.; Martin, W. J. (Oak Ridge National Lab., Tenn.). Feb 1971. Contract W-7405-eng-26. 106p. Dep. NTIS.

The tests conducted in the ORNL LOFT Assistance Program to date are summarized for 15 release experiments conducted in the CRI with the stainless steel liner. The experiments are listed in chronological order along with the conditions of the release. The runs included direct release of radioiodine tracer, release of the CSE simulant, fission product release from melted irradiated fuel, and prompt release on cladding failure. These release experiments completed the initial phase of the LOFT Assistance Program, and salient facts are presented concerning those phases of the experiments which are thought to be of most interest. Data concerning conditions of temperature, pressure, condensation, and time in the containment vessel together with the results of gas sampling, particle sizing, spraying, and deposition testing are given for the experiments. 17 references. (auth)

18177 (RFP–1314) CRITICAL PARAMETERS OF A URANIUM SOLUTION SLAB–CYLINDER SYSTEM. Tuck, Grover; Clark, Harold E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 16 Dec 1970. Contract AT(29-1)-1106. 15p. Dep. NTIS.

Critical parameters are presented for a 490-gram per liter uranyl nitrate (93.2 weight-percent uranium-235) system which consisted of an array of vertical cylinders resting on and interacting with a 120-centimeter square horizontal slab. The parameters varied were the array solution height, the number of cylinders, the cylinder diameter, and the slab thickness. The slab-array system, having nine and sixteen 13.6-centimeter diameter cylinders, was also reflected with a 10.2-centimeter thick reflector. All other measurements were essentially unreflected. The critical thickness of the slab alone was measured also. The effect of two 2-liter bottles of solution near the center of a 16-cylinder array and the effect of vertical separation between the array of cylinders and the solution slab are also described. (auth)

18178 (TID–25646) RESEARCH IN REACTOR CORE PHYSICS. Final Report, January 1960–August 1968. Robeson, Andrew (Virginia Polytechnic Inst., Blacksburg. Dept. of Physics). Contract AT(40-1)-2686. 14p. Dep. NTIS.

A review of research programs carried out in the Virginia Polytechnic Institute Cockcroft-Walton accelerator and research reactor during January 1960 to August 1968 is presented. Technical papers resulting from the research programs are listed. (D.C.C.)

18179 (WHAN-FR–36) PROGRAM STATUS REPORT: SAMPLING OF RADIOACTIVE SODIUM FROM FFTF. Knoll, K. C.; Scott, F. A. (WADCO Corp., Richland, Wash.). Dec 1970. Contract AT(45-1)-2170. 40p. Dep. NTIS.

A technique for sampling the coolant Na of the Fast Flux Facility for impurity analysis is demonstrated. It overcomes the problems presented by the reactivity and radioactivity of the Na. The sample tubes are installed, checked for leaks, filled with Na and sealed by crimping. The samples are cooled rapidly and uniformly to minimize impurity segregation and removed from the sampler. All these operations are performed remotely by using master-slave manipulators. Na flow was regulated and the temperature maintained at the desired levels. Analysis of Na taken from three sections along the sample tube gave no evidence of longitudinal segregation of O_2. Na sealed in tubes by crimping showed no detectable leakage of air through the crimps after as much as 35 days of storage in air. (auth)

18180 (WHAN-FR–50) WADCO QUARTERLY TECHNICAL REPORT, JULY–SEPTEMBER 1970. (WADCO Corp., Richland, Wash.). Jan 1971. Contract AT(45-1)-2170. 552p. Dep. NTIS $10.00.

BORON CARBIDES—radiation effects on microstructure of, in-pile
FAST FLUX TEST FACILITY—safety analysis for
—core design for, progress during July to September 1970
—physics analysis of
—design of, progress during July to September 1970
—components for, development during July to September 1970
—instrumentation for, development during July to September 1970
—control systems for, development during July to September 1970
—fuels for, development and testing of mixed oxide
—coolant for, instrumentation and sampling systems for sodium
NEUTRONS, FAST—effects on mechanical properties and microstructure of stainless steel
REACTOR FUELS—radiation testing of mixed oxide fast
—properties of mixed oxide fast
SODIUM—sampling systems for reactor coolant, development of
—purification systems for reactor coolant, development of
STAINLESS STEEL—radiation effects on, fast neutron
TANTALUM—radiation effects on swelling of, in-pile (H.D.R.,

18181 (WHAN-SA–11) COMPARISON OF TWO-DIMENSIONAL AND THREE-DIMENSIONAL NEUTRONICS CALCULATIONS FOR THE FTR. Hardie, R. W.; Little, W. W. (WADCO Corp., Richland, Wash.). 9 Sep 1970. Contract AT(45-1)-2170. 5p. (CONF-701102–10). Dep. NTIS.

From Meeting of the American Nuclear Society, Washington, D. C.

Although most survey fast reactor physics calculations are performed using either one- or two-dimensional models, certain detailed design computations may require a three-dimensional model. To assess differences between two-dimensional and three-dimensional diffusion calculations, 2DB and 3DB runs simulating the Fast Test Reactor (FTR) were performed. The items investigated include k_{eff}, burnup, fuel worth, poison rod worth, and power peaking. 3 references. (auth)

18182 (WHAN-SA–12) COMPARISON OF CALCULATED AND EXPERIMENTAL WORTHS OF LARGE SAMPLES IN ASSEMBLIES FTR-1 and 2. Omberg, R. P.; Bennett, R. A.; Nelson, J. V. (WADCO Corp., Richland, Wash.). 9 Sep 1970. Contract AT(45-1)-2170. 6p. (CONF-701102–15). Dep. NTIS.

From Meeting of the American Nuclear Society, Washington, D. C.

It has been suggested that sample size may be responsible for the discrepancy between calculated and measured worths in fast assemblies. Whether this is true can be determined from a set of experiments performed in Critical Assemblies FTR-1 and FTR-2 in which the reactivity worths of large samples of fuel and B_4C control material were measured. The assemblies were constructed in the Zero Power Plutonium Reactor. A comparison between calculation and experiment for all the large sample measurements in Assemblies FTR-1 and FTR-2 is presented. 3 references. (auth)

18183 (WHAN-SA–39) LARGE SCALE AIR CLEANING TESTS IN THE CONTAINMENT SYSTEMS EXPERIMENT. McCormack, J. D.; Hilliard, R. K. (WADCO Corp., Richland, Wash.). 11 Nov 1970. 24p. (CONF-700816–7). Dep. NTIS.

From 11th AEC Air Cleaning Conference, Richland, Wash.

Results of five CSE experiments in which an internal recirculating air cleaning loop was run in steam-air atmospheres are presented. The loop was composed of a commercial sized heat exchanger, demister, filters, and charcoal beds. Variables in-

vestigated were loop flow, atmospheric temperature, component arrangement and aerosol source term. The observed removal of iodine, cesium, uranium, and methyl iodide from the typical water cooled reactor post-accident atmospheres is compared to a mathematic model. 14 references. (auth)

18184 DEVELOPMENTS IN NEUTRON SCATTERING AT THE MTR. Brugger, R. M. (Idaho Nuclear Corp., Idaho Falls). pp 197-210 of Instrumentation for Neutron Inelastic Scattering Research. Vienna; International Atomic Energy Agency (1970).

From Meeting on Instrumentation for Neutron Inelastic Scattering Research, Vienna, Austria. See STI/PUB-275; CONF-691220.

Development of several new pieces of equipment and several new methods has been realized recently in the MTR programs of neutron scattering. These developments include samples at high pressures, detection of molecular vibrations, use of correlation choppers, small digital-computer interfacing and intense sources. With the termination of the MTR this fiscal year these programs and future developments will be seriously curtailed. (auth)

18185 UTILIZATION OF NEUTRON GUIDE TUBES FOR NEUTRON INELASTIC SCATTERING. Jacrot, B. (Institut Max von Laue-Paul Langevin, Grenoble, France). pp 225-47 of Instrumentation for Neutron Inelastic Scattering Research. Vienna; International Atomic Energy Agency (1970).

From Meeting on Instrumentation for Neutron Inelastic Scattering Research, Vienna, Austria. See STI/PUB-275; CONF-691220.

Neutron guide tubes which have proved to be very efficient devices now play an important role for the instrumentation around nuclear reactors. The following terms will be reviewed: 1. General principles of conducting tubes; 2. Technical problems in the building of conducting tubes; 3. Description of existing installations with their performance (mostly installations in Munich and Saclay); 4. Specific interest of these tubes for inelastic scattering experiments; and 5. Project of conducting tubes for the High-Flux Reactor at Grenoble. (auth)

18186 REVIEW OF HOT NEUTRON SOURCES. Egelstaff, P. A. (Atomic Energy Research Establishment, Harwell, Eng.). pp 249-68 of Instrumentation for Neutron Inelastic Scattering Research. Vienna; International Atomic Energy Agency (1970).

From Meeting on Instrumentation for Neutron Inelastic Scattering Research, Vienna, Austria. See STI/PUB-275; CONF-691220.

The principles for the design and construction of hot neutron sources in conventional reactors are reviewed and existing neutron sources are described. Sources made of beryllium oxide and graphite have been put into practical use and the performance of these sources is considered. The uses of hot sources are discussed and it is concluded that with present fluxes, their use is limited. However, a wider field of application for hot neutron sources seems likely with the advent of high-flux beam reactors. (auth)

18187 ON-LINE SEPARATION OF ISOTOPES AT A REACTOR IN STUDSVIK (OSIRIS). Borg, S. (Research Inst. for Physics, Stockholm); Bergstroem, I.; Holm, G. B.; (and others). Nucl. Instrum. Methods; 91: 109-16(1971).

An on-line isotope separator system for the study of fission products has been constructed. The ion source, which is placed close to the core of the 1 MW R2-0 reactor, contains the ^{235}U target in order to minimize the transport time of the fission products and to avoid a heated pump line. By keeping the source at a high temperature a wide range of elements are released from the target and subsequently mass separated. So far Zn, Ga, Ge, As, Br, Kr, Rb, Sr, Ag, Cd, In, Sn, Sb, Te, I, Xe, Cs and Ba appear to have been observed. The system has been in operation since the middle of 1968 and has performed most satisfactorily. A large number of nuclides thus has been made available for study, the most short-lived ones, observed so far, having half-lifes in the region of 0.2 to 0.5 sec. (auth)

18188 HIGH FLUX STATIONARY RESEARCH REACTORS AND THEIR PERSPECTIVES. Feinberg, S. M. At. Energ. (USSR); 29: 162-8(Sep 1970). (In Russian).

During the last decade considerable progress has been achieved in nuclear technology, which permits an increase of neutron flux in research reactors. Progress is pointed out in the field of stationary research intermediate reactors with a thermal neutron trap. Additional increase in the neutron flux is discussed. Comparison is made with a project of the fast nucleon accelerator, used as an intensive thermal neutron source. 11 references. (auth)

18189 CAPSULE SYSTEMS FOR MATERIAL IRRADIATION IN HIGH FLUX SM-2 REACTOR. Tsykanov, V. A.; Samsonov, B. V.; Timchenko, R. A.; Shulimov, V. N.; Lobanov, G. P. At. Energ. (USSR); 29: 169-74(Sep 1970). (In Russian).

To irradiate materials in research reactors various devices are used in accordance with objectives and conditions of experiments. Special attention is given to capsule systems developed for high flux SM-2 reactor irradiation of materials. Described are the ampule systems with specimen temperature being measured and controlled during irradiation, those designed for high and intermediate temperature operation. (auth)

18190 MEASUREMENT OF CELL-DEPENDENT NEUTRON SPECTRA IN FAST CORE WITH NUCLEAR EMULSION. Nomoto, Shoji (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: 45-7(Jan 1971).

Neutron spectra were measured in the centers of fast critical assemblies in the FCA facility by means of nuclear emulsions. The neutron spectra averaged for the center cells of the cores indicate some differences due to cell arrangement when compared to calculations. (H.D.R.)

18191 INTERCOMPARISON OF REACTOR CALORIMETERS. REPORT OF INTERNATIONAL MEASUREMENTS MADE IN REACTOR MELUSINE, MARCH 1970. Boyd, A. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Keddar, A. At. Energy Rev.; 8: 949-55(Dec 1970).

Calorimeters of eight reactor dosimetry groups from six member states of the International Atomic Energy Agency were compared in the reactor MELUSINE in March 1970. The average deviation of the results was 3 to 4% and the maximum difference 10 to 12% for measurements at absorbed dose-rates of 100 to 400 mWg^{-1}. The methods of operation included adiabatic and steady-state operation and calibration was done by electric heating or by measurement of the cooling curve. The results confirm the accuracy and validity of reactor calorimetry, thus providing a firm basis for chemical and other methods of reactor dosimetry. 11 references. (auth)

18192 HELIUM HIGH PRESSURE IRRADIATION FACILITY FOR BREEDER FUEL PINS IN THE FR2 REACTOR. Deckers, H.; Lehning, H.; Reiser, H. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Eng. Design; 14: 343-8(Nov 1970).

A helium test loop with 30 kp/cm^2 coolant pressure has been operating in the Karlsruhe research reactor FR2 since 1966 for irradiation of fuel pin specimens. This loop is to be extended by a high pressure irradiation facility. On the one hand, this supplies the high heat transfer numbers which are necessary for testing high power fuel pins for sodium cooled breeders. On the other hand, it permits irradiation tests to be carried out with respect to gas cooled breeders under highly realistic conditions. The expansion covers in particular the construction of a special irradiation rig with an independent high pressure helium cooling circuit of a maximum operating pressure of 150 kp/cm^2. The compressor for circulating the coolant is flanged right onto the irradiation rig. With a gas flow of about 250 kg/h the maximum thermal power of the fuel test pins is about 40 kW. The existing cooling system of 30 kp/cm^2 is used as a secondary circuit for heat removal. The components of that cooling system, especially the purification system and the safety system, retain their previous functions almost unchanged. The high pressure irradiation facility was set up for out-of-pile testing at the Institute of Reactor Development. (auth)

18193 REGIONAL-DEPENDENT REACTOR KINETICS FOR THE UNIVERSITY OF MISSOURI RESEARCH REACTOR: A MODEL DESCRIPTION AND AN EXPERIMENTAL DETERMINATION. Gooden, David Samuel. Columbia, Mo.; Univ. of Missouri (1970). 194p. University Microfilms Order No. 70-20,779.

Thesis.

The University of Missouri Research Reactor consists of several distinct regions which have markedly different nuclear characteristics. The primary regions are the light water flux trap, the core, and the concentric reflectors of beryllium and graphite. A three-node model which predicts the influence of the various regions on the kinetics of the system is presented. The kinetic behavior for each of the regions and their kinetic relationship to one another is obtained. Results of an experimental kinetics study using two-detector, digital noise analysis techniques are also presented. The experimental results show the influence of a combination of regional effects and spatial effects. A qualitative evaluation of the relative influence of regional effects and spatial effects is made by comparing the results obtained for the regional model with the results of the experimental study. The general kinetic behavior of MURR is described well by a three-node model. Differences in the kinetic response of the various regions of MURR are demonstrated conclusively. The experimental values for α, 15.7 ± 0.5 $seconds^{-1}$ is quite closely approximated by the model value of 12.7 $seconds^{-1}$. The experimentally determined and model predicted coherence functions are in excellent agreement. Both show the kinetic behavior of MURR beginning to depart from funda-

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mental mode behavior at approximately 20 cycles/second. (Diss. Abstr. Int., B)

18194 EXPERIMENTAL STUDIES OF EXPERIMENTAL REACTOR IR-100. Konstantinov, L. V.; Martem'yanov, I. N.; Nikolaev, V. A.; (and others). At. Energ. (USSR); 29: 453-4 (Dec 1970). (In Russian).

Results are given of measurements obtained during the startup and operation of IR-100 reactor and the feasibility of increasing its output. Tabulated data are given on the thermal neutron flux and γ-dose in the vertical experimental channels at the nominal reactor power of 100 kW. The thermal and fast neutron fluxes and the γ-radiation dose at the outlet of the horizontal experimental channels at 100 kW are given. The operations of the reactor showed that the cooling system had a large reserve and the reactor power could be increased up to 200 to 300 kW without any significant increase of the active zone load. (R.V.J.)

18195 REACTOR CORE STRUCTURE. Ide, Akira (Fuji Electric Co. Ltd., Tokyo); Hosonuma, Satoshi. FAPIG (Tokyo): No. 56, 245-9(Mar 1970). (In Japanese).

The core structure of DCA is composed of pressure tubes, calandria tubes, a core tank, upper and lower grids, the lower absorber for the realization of bare core, the pipes for supplying and exhausting D_2O or cover gas, and insert pipes. As the structural material, aluminum is mostly used. Starting neutron source and PNS are inserted through the side wall of the tank. The production of aluminum core tank is very difficult, and new techniques were required. For example, because of the thick plate structure, welding was the first problem. Various tests were performed under varying conditions of gas, torch, edge preparation shape, etc. As the welding defect, blow holes were conspicuous, and the parts where one structural element is welded to others are problematical. For cutting thick plates, plasma arc was used. Moreover, because of the high accuracy and complexity of fabrication and the multiplicity of inspection, various production techniques were used. (Japan)

18196 EXPERIMENTAL D_2O CRITICAL ASSEMBLY (DCA). Ando, Tetsuya; Ide, Akira (Fuji Electric Co. Ltd., Tokyo). FAPIG (Tokyo): No. 56, 237-41(Mar 1970). (In Japanese).

Experimental D_2O Critical Assembly (DCA), for the development of an Advanced Thermal Reactor (D_2O moderated and light-water cooled), was constructed and went critical in December 1969. The purpose of DCA is to obtain information on the ATR, including D_2O level reactivity worth, neutron-flux distribution, bucking and control-rod equivalent reactivity. It consists of the core tank, made up of calandria tubes and tank; fuel rods in pressure tubes are inserted in the calandria tubes, and the tank is filled with D_2O. Then in association with this are installed the reactor-control mechanism, heavy water, light water and gas systems, fuel-handling equipment, nuclear and process instrumentation, and experimental facility. (Japan)

18197 HEAVY-WATER CRITICAL ASSEMBLY. Ide, Akira; Yoshida, Noriaki; Isozaki, Osamu (Fuji Electric Co. Ltd., Tokyo). Fuji Jiho; 43: 397-406(Apr 1970). (In Japanese).

The Heavy Water Critical Assembly to study the nuclear characteristics of the ATR being developed in Japan is described. The studies include the reactivity worth of D_2O level, neutron flux distribution, buckling, control-rod reactivity equivalent, etc. HWCA consists of the calandria tank and calandria tubes; D_2O fills the tank, and fuel is in pressure tubes. Criticality is attained by means of the level of D_2O moderator. The core lattice pitch can be in three patterns by exchanging the grid plates; the control is by control rods. Light-water (for core cooling) system with temperature regulation and gas system to prevent D_2O deterioration and to dry the tank are also installed. Finally its construction on the site is described. (Japan)

Rocket and Space Reactors

18198 (GESR-2123) TECHNICAL INFORMATION IN SUPPORT OF THERMIONIC REACTOR EXPERIMENT FACILITY COST ESTIMATE. (General Electric Co., Pleasanton, Calif. Nuclear Thermionic Power Operation). Feb 1970. Contract AT(04-3)-771. 416p. Dep. NTIS.

The technical description and accompanying backup data used to generate the Thermionic Reactor Experiment (TREX) cost estimate are presented. Guidelines for the facility include: reactor power level at least 100 kW(e); ^{235}U fueled thermionic fuel elements; a fast neutron spectrum; and a reflector which mocks up a 4 π shieldable flight reference design. The concept is described beginning with the fuel element and including the core structure, reactor vessel and dome, reflector cup and lift, and reactor design. The TREX control philosophy, power conditioning equipment, and instrumentation and control are discussed. Sections are included describing coolants, the overall facility and proposed modifications, safeguards, and schedule. 33 references. (H.D.R.)

18199 (N-70-36660) CRITICALITY STUDY OF MELTDOWN CONFIGURATIONS FOR NUCLEAR AIRCRAFT REACTORS. Lennon, Conrad J.; Hyland, Robert E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug 1970. 20p. (NASA-TM-X-2068; E-4973). NTIS.

As part of a containment system study for the nuclear aircraft reactors, a description of the meltdown problem is presented along with curves of reactivity for reflected and unreflected slabs, spheres, and cylinders as a function of UO_2 fuel loading, composition and size. These are presented to help the early design concepts avoid configurations that would cause excursions in the event of a core meltdown and thereby obtain a feasible containment system. Results are presented which indicates that masses that have melted down from reactors can be kept subcritical provided certain geometrical dimensions for specific dilutions of fuel are not exceeded within the containment system. (auth) (STAR)

18200 (N-70-39389) NEUTRON KINETICS OF A FAST, HOT, CRITICAL ASSEMBLY IN THE STARTUP MODE. Niederauer, George F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sep 1970. 45p. (NASA-TM-X-2078; E-5289). NTIS.

A reactor for auxiliary power in space was designed using ^{235}UN fuel in a tantalum structure with ^{7}Li coolant. The kinetics of a hot critical assembly of the same design with and without coolant was parametrically studied in the startup mode to determine safe operating ranges of ramp reactivity inputs. The main parameters considered were wide ranges in the magnitudes of the Doppler and thermal expansion reactivity coefficients and several kinds of expansion effects. (auth) (STAR)

18201 NUCLEAR AIRPLANE NOW! Miller, M. M. (Lockheed-Georgia Co., Marietta). Ind. Res.; 12: No. 3, 48-50(Mar 1970).

Advances in the technology of nuclear reactors, heat transport systems, shielding and containment materials, and engine efficiency are described. The potential for successful development of nuclear airplanes is discussed. (H.D.R.)

18202 OPTIMIZATION OF THE CELL DIMENSIONAL PARAMETERS OF AN IN-CORE THERMIONIC FUEL ELEMENT. Wolf, E.; Haug, W. (Univ., Stuttgart). Atomkernenergie; 16: 213-18(1970). (In German).

Performance data of in-core thermionic fuel elements with series-connected converters are determined by means of a theoretical model in a wide range of operational and geometrical parameters and used to optimize several of such parameters. In general the single cells are differently heated in the reactor core. The effect of this nonuniform heat generation on the total output data is investigated. A method for power enhancement by means of variation of converter lengths or interconnection lead geometries in the fuel elements is discussed. 11 references. (auth)

18203 MUTUAL NEUTRON INTERCHANGE THROUGH VACUUM BETWEEN BOUNDARY SURFACES OF REACTOR PARTS. Speidel, V.; Wolf, E. (Univ., Stuttgart). Atomkernenergie; 16: 196-200(1970).

A theoretical model for studying the mutual neutron interchange through vacuum between arbitrarily arranged parts of reactor medium is presented. For the special case of plane polar coordinates the model is formulated in the form of boundary conditions of the diffusion theory and compared to experimental data of SNAP Experimental Reactor. The method is suitable for reactor physical calculations of reactors having movable reflector parts for control purposes. 11 references. (auth)

Process Heat and Desalination Reactors

18204 (ORNL-4293) DATA OBTAINED ON SEVERAL POSSIBLE LOCALES FOR THE AGRO-INDUSTRIAL COMPLEX. Tamura, T.; Young, W. J.; Yarosh, M. M. (Oak Ridge National Lab., Tenn.). Feb 1971. Contract W-7405-eng-26. 45p. Dep. NTIS.

Supplementary information to Chapter 8 of ORNL-4290, Nuclear Energy Centers: Industrial and Agro-Industrial Complexes is

presented. Information collected on the several locales chosen as representative of those which might have potential for future development of the energy center concept is discussed and documented. In addition to the data given for specific locales, principally in developing countries of the world, an appendix contains selected data on the 37 countries having coastal deserts. (auth)

18205 (ORNL-TM-3149) ORVE: A FORTRAN CODE FOR THE CALCULATION OF A DESALINATION PLANT COMBINING VERTICAL EVAPORATORS WITH MSF FEED HEATING. Friedrich, R. O.; Hafford, J. A. (Oak Ridge National Lab., Tenn.). Sep 1970. Contract W-7405-eng-26. 217p. Dep. NTIS.

A program was written for the IBM-360 system which designs a vertical evaporator desalination plant. All pertinent plant parameters such as temperatures, flows and concentrations are calculated, along with a detailed cost analysis of the various plant components. Costs are based on third quarter 1967 dollars. The plant consists of a vertical-tube portion physically located above an MSF feed heater. Both are enclosed in a steel and concrete shell. A reactor plant supplies heat and electricity on an optional basis. The output from the program contains all necessary plant operating parameters, along with a detailed cost output. (auth)

18206 POSSIBILITIES OF NUCLEAR ENERGY FOR METALLIC AND CHEMICAL PROCESSES. Wenzel, Werner (Technische Hochschule, Aachen). Tech. Ueberwach.; 10: 407-11(Dec 1969). (In German).

By means of nuclear power stations integrated into metallurgical plants it will be possible to reduce the cost of iron and steel production. The heat required for the reduction of iron ore can be directly drawn from a high-temperature pile and led via heat exchangers to the reduction process during the first step towards the production of iron sponge. The useful heat still remaining in the reactor coolant will be used for the generation of electrical energy for the metallurgical plant. (auth)

18207 NUOVI ORIZZONTI PER L'ENERGIA NUCLEARE. Atti del XIV Congresso Nucleare, Roma, 20–21 Marzo 1969. (Nuclear Conference on New Horizons for Nuclear Energy. Proceedings of the 14th Conference, Rome, March 20–21, 1969). Serie Simposi. Roma; Comitato Nazionale Energia Nucleare (1970). 352p. (In several languages). (CONF-690325).

Information on the development of dual purpose desalination and power reactors is presented. Separate abstracts are included for 15 of the 16 papers presented. One paper on radiation chemistry has been previously abstracted and listed in NSA. (D.C.C.)

For abstracts of individual papers see: 15810, 18054, 18077, and 18208–18219.

18208 DESALINATION. Eklund, S. (International Atomic Energy Agency, Vienna). pp 19-29 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

A general description of fresh water requirements for world populations is presented. The use of process heat reactors for the production of electricity and fresh water is reviewed. Development programs for desalination plants are discussed. (D.C.C.)

18209 POWER AND WATER IN A CROWDED WORLD. Young, G. (Oak Ridge National Lab., Tenn.). pp 31-102 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

A review of changes in fresh water requirements and uses with the chronological development of populations is presented. The use of process heat reactors for the production of electricity and fresh water is described. Predicted requirements of desalination plants for future populations are presented. Economic factors related to the development of nuclear powered agro-industrial complexes are analyzed. 89 references. (D.C.C.)

18210 U.K. APPROACH TO DESALINATION AND NUCLEAR POWER. Kronberger, H. (United Kingdom Atomic Energy Authority, London). pp 133-46 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

A review of development programs in U.K. for dual purpose desalination and power reactors is presented. The use of a steam generating water-cooled and heavy water-moderated reactor for production of fresh water and electricity is described. (D.C.C.)

18211 PRESENT STATUS OF DESALINATION. PROGRAMS AND ACTIVITIES IN ISRAEL. Adar, J. (Israel Atomic Energy Commission, Tel Aviv). pp 147-61 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

The development of dual purpose desalination and power reactors in Israel is reviewed. Various desalination processes are described. 8 references. (D.C.C.)

18212 SPANISH ACTIVITY ON SEAWATER AND BRACKISH WATER DESALINATION. Pascual, F. (Junta de Energia Nuclear, Madrid). pp 163-77 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

The development of dual purpose desalination and power reactors in Spain is reviewed. Various methods for desalination are described. 4 references. (D.C.C.)

18213 STATUS OF ADVANCES IN THE ROVI PROGRAM. Di Menza, R. (CNEN, Rome). pp 179-91 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970). (In Italian).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

Design parameters and operations aspects for the 222 MW ROVI reactor are presented. 5 references. (D.C.C.)

18214 U. S. PROGRAMS AND ACTIVITIES IN NUCLEAR DESALTING. Costagliola, F. (Atomic Energy Commission, Washington, D. C.). pp 193-201 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

A brief review of U. S. development programs for dual purpose desalination and power reactors is presented. (D.C.C.)

18215 NUCLEAR DESALINATION: A CHALLENGE FOR AN ECONOMIC SMALL REACTOR. Quarrington, J. A. (Atomic Energy of Canada Ltd., Ottawa). pp 203-11 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

Economic factors concerning the development of small dual purpose desalination and power reactors are analyzed. (D.C.C.)

18216 FRENCH PROGRAM FOR THE STUDY OF DESALINATION AND PROSPECTS FOR USE OF NUCLEAR ENERGY. Piatier, H. (CEA, Fontenay-aux-Roses, France). pp 213-22 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970). (In French).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

Development programs in France for dual purpose desalination and power reactors are reviewed. (D.C.C.)

18217 PRESENT STATUS AND FUTURE PROSPECTS OF SEA-WATER DESALINATION IN JAPAN. Hashimoto, Seinosuke (Japan Atomic Industrial Forum, Inc., Tokyo). pp 223-38 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

The development of dual purpose desalination and power reactors in Japan is reviewed. Economic factors related to dual purpose reactor operation are analyzed. (D.C.C.)

18218 NUCLEAR DUAL PURPOSE POWER AND DESALINATION PLANTS: TECHNO-ECONOMIC CONSIDERATIONS. Sunder Rajan, N. S.; Thomas, K. T. (Bhabha Atomic Research Centre, Bombay). pp 239-63 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

Economic factors related to the development and operation of dual purpose desalination and power reactors are analyzed. Reactor types are compared for optimum economics. (D.C.C.)

18219 IMPACT OF NEW DEVELOPMENTS ON ECONOMIC AND INDUSTRIAL PROGRESS. Timbs, M. C. (Australian Atomic Energy Commission, Coogee). pp 325-35 of Nuovi Orizzonti per l'Energia Nucleare. Roma; Comitato Nazionale Energia Nucleare (1970).

From 14th Nuclear Conference, Rome, Italy. See CONF-690325.

A review of development programs for nuclear power plants and for dual purpose desalination and power reactors is presented. Other peaceful uses of atomic energy are briefly described. (D.C.C.)

18220 FEASIBLE NON-UTILITY NUCLEAR POWER PLANTS. Yabe, Goro (Asahi Chemical Industry Co. Ltd., Osaka). Ohm (Elec. Mag.); 57: No. 8, 34-9(Aug 1970). (In Japanese).

XUM

A nuclear power plant is the most suitable as a non-utility, i.e., enterprise-owned, means of producing electricity and also steam; it is economical and without public hazards. Even a medium light-water reactor plant is competitive with the thermal power plant. First, the environment to make economically possible non-utility power plants in general is outlined. In producing both electricity and process steam in a non-utility nuclear plant, the allocation of the respective costs is important. The procedure in this connection, based on the "exergie" concept, is explained. Then, the site conditions necessary for a non-utility nuclear power plant are listed. Finally, as an example of the non-utility nuclear power plant, one for producing 200,000 tons per year of aluminum is taken up; the steam requirement is 300 tons/hr and the electrical power is 450,000 kW. (Japan)

18221 NUCLEAR DESALINATION APPROACHING ITS PRACTICAL APPLICATIONS. Suetsuna, Ichiro (Japan Atomic Industrial Forum, Inc., Tokyo). Ohm (Elec. Mag.); 57: No. 8, 55-62(Aug 1970). (In Japanese).

To cope with the problem of water-supply shortage, nuclear desalination by a multi-purpose reactor is attracting increasing interest. The general methods of desalination are explained: evaporation, membrane, and freezing. As the advantages of nuclear desalination, there are the large scale of desalination, benefit in the usage of enthalpy, relative freedom in the desalination sites, and stabilized electric-power generation. In the calculation of desalination and power costs in a dual-purpose reactor plant, a procedure is presented: the cost of common facilities for desalination and power generation is shared according to the respective enthalpies, and then the cost of separate facilities is obtained accordingly. To improve the economy of the dual-purpose plant, its operation with as full loads as possible is necessary. Problems of a desalination-plus-power plant in the industrial complex are indicated. (Japan)

Marine and Portable Power Reactors

Refer also to abstract 16547.

18222 (DOCKET-50238-77) N. S. SAVANNAH. Abnormal Occurrence Report: X-Ray Inspection of Pressurizer Safety Valves. (Maritime Administration, Washington, D. C.). 10 Feb 1971. 2p. Dep. NTIS.

18223 (EUR-4487) NUCLEAR RESEARCH SHIP "OTTO HAHN." Annual Report, 1968. (Gesellschaft fuel Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). Nov 1970. 60p. (In German). Dep. NTIS (U. S. Sales Only). EUR DM 7,30.

A summary of the work which remains to be done to complete the ship is presented. The proving voyages made during 1968 are described. (auth)

Production Reactors

18224 (BNWL-SA-3679) EFFECTS OF HANFORD REACTORS ON COLUMBIA RIVER AND ADJACENT LAND AREAS. Foster, R. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1970]. 48p. (CONF-701205-1). Dep. NTIS.

From Washington Ecological Commission Conference, Richland, Wash.

The history of the plutonium production reactors at Hanford is presented, and the early environmental studies in the plant area are described. The means by which the reactor operations contribute radionuclides and thermal effluents to Columbia River and the effects of these effluents on the ecology of the area are discussed. Comprehensive studies over more than 25 years indicate radiation doses to the public have been well within the guidelines and that no discernible radiation or thermal effects have occurred to the fish and wildlife populations. (H.D.R.)

18225 (TID-25634) SUMMARY OF STUDIES ON THE SAVANNAH RIVER, 1951-1970 FOR E. I. du PONT de NEMOURS AND COMPANY. (Academy of Natural Sciences of Philadelphia, Pa. Dept. of Limnology). Nov 1970. 106p. Dep. NTIS.

During 1951 and 1952, a base line study of the Savannah River was conducted. It took into consideration all of the major groups of aquatic organisms, protozoa, lower vertebrates, insects, fish, and algae, together with the general chemical and physical characteristics of the river. Conducted in the vicinity of the Savannah River Plant, the study was designed to provide a comprehensive picture of the river so that future changes that might occur in the river could be determined. Subsequent surveys were conducted in 1956, 1960, 1965, and 1968 and the results compared to the base line data. The results of the studies, the comparisons made with the base line data, and conclusions based on these comparisons are presented. Of interest concerning the Savannah River Plant, it was concluded that there was no evidence, in any of the areas studied, of the effects of increases in temperature in the river caused by activities of the Savannah River Plant. (E.R.B.)

Reactor Theory

18226 END SLOPE AND FUNDAMENTAL FREQUENCY OF VIBRATING FUEL RODS. Passig, E. G. (Westinghouse Electric Corp., Pittsburgh). Nucl. Eng. Design; 14: 198-200(Nov 1970).

An analytical tool is presented for calculating both the fundamental frequency and the end slope per unit amplitude of a rod supported by two adjacent grids for arbitrary support fixities. 7 references. (auth)

Kinetics

Refer also to abstracts 16019, 17668, 18177, and 18181.

18227 (EURFNR-864) FAST NEUTRON SCATTERING MODELS, SLOWING DOWN AND FORMATION OF REACTOR SPECTRA. Kuesters, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Sep 1970. 41p. (KFK-1295). Dep. NTIS (U. S. Sales Only).

Work performed under United States-Euratom Fast Reactor Exchange Program.

A review is presented covering the models of neutron slowing down calculations in both thermal and fast reactors. To understand the physical nature of the processes which form the reactor spectrum, slowing down is investigated in an infinite medium. The performance of space dependent calculations in homogeneous as well as in heterogeneous media is outlined. (31 references) (auth)

18228 (HUX-3971-5) ANGULAR SINGULARITIES OF ELLIPTIC PROBLEMS. Birkhoff, Garrett (Harvard Univ., Cambridge, Mass.). [1970]. Contract AT(30-1)-3971. 20p. Dep. NTIS.

Criticality calculations for nuclear reactors are commonly based on low-order difference approximations to the multigroup diffusion equations in plane sections. The results reported here concern the possibility of developing "finite element" variational methods having higher-order accuracy. Typically, plane sections of nuclear reactors refer to piecewise homogeneous media separated by interfaces with corners, where the "flux" becomes non-analytic and has what may be called an angular singularity. If one wishes to apply methods having a high order of accuracy to the approximate solution of such problems, one must know the analytical nature of the angular singularities which the solution (flux) has near such corners. The objective of the paper is algorithmic in nature: to find the simplest possible singular basis functions which will achieve a given order of accuracy. In particular, the explicit solution of one-group diffusion equations near simple angular singularities is examined. (R.W.R.)

18229 (ORNL-TM-2580) CODE XITRAN-2: DESCRIPTION AND INSTRUCTIONS FOR USE. Wilson, J. V. (Oak Ridge National Lab., Tenn.). 8 Jan 1971. 51p. Dep. NTIS.

XITRAN-2 is a Fortran 4 code for determining the time constants and spatial shapes of the noninteracting linearized perturbation modes of xenon instability in nuclear reactors with one or two neutron groups, and flux-dependent feedback. The method of harmonic expansion is used in slab, spherical, infinite cylinder, XY, RZ, or Rθ geometry. This method is not recommended for calculating steady-state flux distributions, or for calculating a history of reactor states. 3 references. (auth)

18230 SPATIALLY DEPENDENT STOCHASTIC BEHAVIOR OF COUPLED CORE REACTORS. Nagy, Mohamed El-Sayed. Ames, Ia.; Iowa State Univ. (1970). 111p. University Microfilms Order No. 70-18,896.

Thesis.

An analysis of the behavior of the space-dependent spectral-density functions for the thermal group flux of a two-energy group approximation for a one-dimensional model of an Argonaut-type reactor is presented. The input function is assumed to be white noise generated by volume-distributed fission sources. The work describes the effect of changing the thickness and material of the coupling region (internal reflector) on the behavior of the spa-

tially-dependent spectral-density functions and the corresponding coherence function. Graphite, heavy water, and beryllium are considered as internal reflectors. The effect of the fast-removal and thermal-absorption cross sections of the coupling region on the behavior of the spectral-density functions is also investigated. A neutron-wave model is developed and used to explain the trends predicted by the noise model. The results provide a description of the behavior of the "sink frequency" associated with the cross spectrum as a function of the coupling-region parameters. The sink frequency is defined, for a symmetrical reactor, as the frequency at which the cross spectrum passes through zero. For a symmetrical reactor and observation points the cross spectrum is real. It is shown that the sink frequency is sensitive to the size and nuclear properties of the coupling region, decreasing with an increase in size and in removal and absorption cross sections. (Diss. Abstr. Int., B)

18231 NUMERICAL SOLUTION OF THE LINEAR INTEGRAL BOLTZMANN EQUATION. Cullen, Dermott Edward. New York; Columbia Univ. (1969). 364p. University Microfilms Order No. 70-16,998.

Thesis.

The linear integral Boltzmann equation as applied to neutron and photon transport problems normally encountered in reactor core and shield design is investigated. The multi-group approximation is introduced in order to reduce the energy-dependent Boltzmann equation to a set of coupled group-averaged equations. The original problem is then demonstrated to be equivalent to a coupled set of integral equations in which the kernels may be physically related to a noncollision probability. The kernels for the integral equations are studied in detail for the special case of plane and spherical geometries. It is demonstrated that in these cases the kernels are simply related to the well-known exponential integral functions. Numerical techniques for evaluating these kernels are outlined. The kernels are used to obtain numerical solutions to critical and source problems in plane and spherical geometries. By using an iteration technique that is equivalent to a successive collision method, an asymptotic behavior for the flux is demonstrated. This asymptotic form is used to optimize the iteration procedure and to extend analytically the methods outlined to energy-dependent problems. Consideration is then given to further optimizing the method outlined by the use of relaxation techniques. Methods of selecting optimum relaxation factors are considered. Computer codes developed in the course of this work include not only monoenergetic codes involving inhomogeneous media, but also a 100-group anisotropic scattering code. (TSS) (Diss. Abstr. Int., B)

18232 IMPROVED FAST REACTOR SPACE–ENERGY SYNTHESIS. Cockayne, John Edwin. Lafayette, Ind.; Purdue Univ. (1970). 112p. University Microfilms Order No. 70-18,615.

Thesis.

Space–energy synthesis of multigroup diffusion theory is improved by using "realized" spectra, developing a procedure to calculate "realized" spectra, and devising a successive synthesis to yield highly accurate results for two-region fast-reactor problems. Extensive study of a set of spectra representing the blanket showed that accurate results are possible only if the second spectrum in the synthesis is closely realized at some point in the blanket. For two-mode synthesis in a simple core-and-blanket configuration, this spectrum is calculated a priori as the solution of an inhomogeneous zero-dimensional problem. This spectrum is approximately realized at 17 cm into the blanket from the core–blanket interface. The remaining inaccuracies for the good two-mode synthesis were found to have a strong peak near the interface. A factorization technique using an approximate synthesis solution is developed for calculating the spectrum, at any location in the reactor, from a zero-dimensional problem. In the transition area around the interface, this factorized spectrum is substantially better than the good two-mode-synthesis result, and much better than any spectrum calculated for this transition area which is not based on an approximate solution. The availability of "realized" spectra, from an approximate two-spectra solution and the factorization technique, leads to devising a successive synthesis approach where the synthesis is applied twice. The approach results in highly accurate energy-integrated quantities for three-mode (one original and two new) applications to two-region problems. The successive space–energy synthesis has great potential for power-flattened (i.e., multi-region) fast-reactor configurations. (Diss. Abstr. Int., B)

18233 EFFECT OF RANDOM FUEL ELEMENT DISPLACEMENT ON NEUTRON REACTION RATES. Barrett, P. R. (Univ. of New South Wales, Sydney). Atomkernenergie; 16: 191-5 (1970).

The effect of random displacement of fuel elements (induced by, for example, fuel element bowing owing to neutron irradiation) upon neutron fluxes and reaction rates in a lattice cell is examined for the case of an array of a large number of lattice cells in each of which the probability distribution for the fuel element displacement is the same. This is illustrated in the example of a single thermal neutron energy group with a slowing down source that is spatially uniform in the moderator and zero in the fuel, using the collision probability approach to transport theory in the flat flux approximation. It is shown that relatively small magnitude random displacements of the fuel elements can lead to significant variance to mean ratios in the neutron flux levels. (auth)

18234 EFFECTIVE CALCULATION OF ONE-DIMENSIONAL NUCLEAR REACTORS WITHOUT USING MESH METHOD. Glushkov, E. S.; Ponomarev-Stepnoi, N. N.; Petushkova, N. A. At. Energ. (USSR); 29: 370-1(Nov 1970). (In Russian).

A method based on the analytical solution of diffusion type equations with a known right side of the equation is suggested for calculations of one-dimensional nuclear reactors. With the right side of the equation obtained the solutions found for the neutron fluxes were reduced into series according to the spatial harmonics which permitted consequent approximations to be carried out using the source fission neutrons in analytical concept independent of the number of approximations. Calculations made for cylindrical reactors in four-group approximation demanded less time than the existing net-point method and the effective coefficient of neutron breeding is within the order of error of the other system. (R.V.J.)

18235 NEW METHOD FOR DETERMINING THE RESERVE REACTIVITY. Kosaly, Gyorgy (Central Research Inst. for Physics, Budapest). Fiz. Szemle; 20: 253-7(Aug 1970). (In Hungarian).

The problem of reactor neutron economy was examined. The study was based on the determination of the reactivity of a specific region of the core, deriving a statistical weight for the whole reactor. Determination of the available reserve reactivity is of great economic interest because it influences the reloading cycle of the reactor. A model reactor was set up for the calculation, assuming that the reserve reactivity is counteracted by absorbers. Numerical calculations based on the curves obtained from the model yielded values which agreed with data derived from experiments with the ZR-2 reactor of the Central Research Institute for Physics. (TTT)

18236 STUDY ON APPROXIMATE METHODS FOR CALCULATING THE NEUTRON FLUX IN A HETEROGENEOUS REACTOR. Ukai, Seiji (Kyoto Univ.). J. Nucl. Energ.; 479-91(Dec 1970).

A mathematical procedure is presented for the formulation of two typical approximation methods for solving the neutron transport (or diffusion) equation of a heterogeneous reactor, the homogenization method based on the unit cell model and a heterogeneous method. The limitation of their validity is discussed. For these purposes the transport equation is transformed into a set of integral equations whose unknowns are boundary values of neutron flux at interfaces between the moderator and fuel or absorber lumps and whose kernels are Green's functions for homogeneous media composed of the moderator or lump's materials. This transformation also provides a new approximation technique. (auth) (UK)

18237 NUMERICAL SOLUTION OF A SET OF INTEGRAL EQUATIONS ARISING IN THE STUDY OF NUCLEAR REACTORS. Chiarella, C. (New South Wales Univ., Kensington, Australia. Wollongong Univ., College, Australia). pp 491-3 of Proceedings of the Fourth Australian Computer Conference, Adelaide, South Australia, 1969. Vol. 1. Adelaide; Australian Computer Society Inc. (1969).

See CONF-690837.

An algorithm based on the use of Simpson's rule is derived and attention is focused on the problems encountered in the choice of an indexing system and the procedure for changing the step length. A program based on this algorithm has been written for the IBM 360/50H computer and is used to study the feasibility of various reactor systems. (auth) (Australia)

18238 EMPIRICAL EQUATION OF NEUTRON DIFFUSION SYSTEM APPLICATION OF THE EXPERIMENTAL DESIGN TECHNIQUE. Hoshino, Tsutomu (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 610-14(Dec 1970).

An empirical equation between the cross sections and criticality factor was derived by the technique of experimental design and regression analysis. Factorial experiments taking account of interactions between factors were designed with use made of the orthogonal array. Numerical calculation of a two-group, two-core system was performed and an empirical equation derived by regression analysis, resulting in a criticality factor with acceptable accuracy. 9 references. (auth)

XUM

18239 BINOMIAL FORMULATION OF PROMPT NEUTRON EMISSION PROBABILITY. Hara, Fumio (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 635-41(Dec 1970).

The prompt neutron emission probability of ^{233}U, ^{235}U, and ^{239}Pu is formulated through the convolution of two binomial distributions derived from a simple model representing the nuclear fission processes. Numerical calculations covering several hundred values of parameters characterizing the above distributions have resulted in a probability distribution in good agreement with the experimental results obtained by B. C. Diven et al. Comparison is made between the newly obtained probability distribution and R. B. Leachman's theoretical values as well as with Poisson's distribution, with results in favor of the present calculations. Statistical testing of curve fitting by means of the Kai-square testing technique was also applied. Physical considerations on the nuclear fission process substantiate the validity of the numerically obtained values for the above mentioned parameters. (auth)

Dynamics

18240 DESCRIPTION OF SPACE-TIME DYNAMIC BEHAVIOR OF NUCLEAR REACTOR SYSTEMS. Rohr, Paul Charles. Troy, N. Y.; Rensselaer Polytechnic Inst. (1970). 178p. University Microfilms Order No. 70-19,949.

Thesis.

A study of semidirect modal synthesis methods with specific applications to the dynamics of nuclear-reactor space-time systems is presented. Green's Function modes are used, and the considerations are limited to one-dimensional slab geometry. Some extensions to other geometries and more energy groups are included. Three formulations—Galerkin, Least Squares Variations, and Discontinuous Variational Method—are studied over a range of static test problems to determine figures of merit that predict how well the formulation uses the information available in the modes and how well the formulation and the modes can synthesize in both space and time. The figures of merit are the eigenvalue perturbation (δk) and a tilt parameter; the former is a measure of the time-dependent behavior of the system as a whole, while the latter is sensitive to the shape of the power distribution at a given time. Based upon these figures of merit, the Discontinuous Variational Method (DVM) performed significantly better over a range of problems than did either of the other methods. Further tests of the DVM included larger size perturbations, localized positive perturbations, and an eigenvalue spectrum analysis that measured the ability of the formulation to predict (synthesize) higher eigenvalues. The ability of the DVM to synthesize peaks in the overtones, where there is no peak in the trial functions, through the use of discontinuities is clearly demonstrated. The final test of the DVM was a series of severe time-dependent maneuvers initiated by rod-ejection accidents. Exact calculations for comparison were provided. Some limitations of the basic method are outlined, and possible improvements to the method are discussed. Some of the time-dependent space-time maneuvers had severe enough perturbations to show the limitation of the Green's Function modes. The sensitivity of the results to the accuracy of the derivative of a trial function at the interface between source and sink regions is evaluated. An indirect method using previously calculated integrals improves the estimate of this derivative. It is also established that, if a formulation has an inherent difficulty in using the information of a particular set of modes, the results are not drastically improved by using the same functional with more modes. (TSS) (Diss. Abstr. Int., B)

18241 EXPECTED NUMBER OF SUBASSEMBLY FAILURES DUE TO HOT SPOT OCCURRENCES. Amendola, A. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Sci. Eng.; 43: 239-40(Feb 1971).

The effects of core-wide and local uncertainties upon the expected number of subassemblies in which at least one hot spot occurs are analyzed. It is concluded that assuming all channels to be independent results in a conservative estimate of the overall hot spot probability, but the correlations between the channels cannot be neglected if the expected number of failed elements is assumed as the principal reliability criterion. (H.D.R.)

Experimental Applications

18242 EVALUATION OF PUBLISHED DELAYED-NEUTRON PARAMETERS FOR ^{235}U AND ^{233}U HEAVY WATER SYSTEMS. Church, J. P. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Nucl. Sci. Eng.; 43: 229-33(Feb 1971).

The results of three different methods used for the determination of delayed-neutron and photoneutron parameters are compared and evaluated. The parameters were simulated by computer for the experimental determinations using chopper, pulse, and saturation irradiations. (H.D.R.)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 15485, 15812, 15813, 15815, 15820, 15822, 15823, 15830, 15860, 15861, 15915, 15921, 15965, 15966, 15978, 15983, 16439, 16557, 16561, 16562, and 16614.

18243 (TRG-Report-1915) BOWING OF A HEATED ELEMENT COOLED BY FORCED CONVECTION. Rapier, A. C. (United Kingdom Atomic Energy Authority, Sellafield (England). Reactor Group). 1970. 24p. Dep. NTIS (U. S. Sales Only). UK 3s. 6d.

When unsymmetrical conditions exist around a heated element cooled by flow in a channel, there will be temperature variations around its circumference. This will result in a tendency for the hottest side of the element to bow away from its normal axis. Usually a movement in this direction results in a reduction of the heat transfer coefficient and an increase in the local coolant temperature on the hot side, inducing greater temperature differences around the element and further movement. Under some conditions this can lead to complete instability. This problem was previously examined for the case of an element simply supported at each end with reference to fuel elements for nuclear reactors. The generality of previous solutions is extended to cover any channel shape and any number of spans. Explicit functions are derived for the final shape of the element, the temperature distribution along it and the forces on the supports. (auth) (UK)

18244 (WHAN-SA-40) LEAKAGE FROM A CONTAINMENT VESSEL. Hanthorn, Howard E. (WADCO Corp., Richland, Wash.). 11 Nov 1970. Contract AT(45-1)-2170. 15p. (CONF-700816-6). Dep. NTIS.

From 11th AEC Air Cleaning Conference, Richland, Wash.

An attempt was made to obtain a unified expression for leakage flow from a nuclear reactor containment vessel. Such an expression would be useful particularly in investigations of the consequences of postulated reactor accidents occurring within containment vessels. It was found that the curves for leakage rate vs containment vessel overpressure for the three flow regimes (viscous, turbulent, and orifice) were of the same general form and could be fitted with ample accuracy by empirical mathematical formulas of the same type, though the range of flow rate covered was six orders of magnitude. A single empirical formula was obtained covering all three flow regimes with sufficient accuracy for source term calculations without regard to the actual flow regime, between 0.3 and 5 atm overpressure. (auth)

18245 (WHAN-SA-70) CERAMIC FUELS. Evans, E. A.; Sheely, W. F. (WADCO Corp., Richland, Wash.). Oct 1970. Contract AT(45-1)-2170. 36p. (CONF-701035-1). Dep. NTIS.

From Meeting on Education and Research in the Nuclear Fuel Cycle, Norman, Okla.

The advances in the technology of production and testing of oxide fuels are reviewed. Some of the problems in the development of plutonium-enriched ceramic fuels are discussed, and the programs and test facilities involved in plutonium fuel technology are described. (H.D.R.)

18246 (WHAN-SA-80) ENERGY TRANSPORT IN OXIDE FUEL MATERIALS. Christensen, J. A. (WADCO Corp., Richland, Wash.). 9 Nov 1970. Contract AT(45-1)-2170. 6p. (CONF-701033-1). Dep. NTIS.

From US-UK Exchange Discussion on Plutonium, Chicago, Ill.

The laser flash diffusivity technique used to measure the thermal conductivity of PuO_2–UO_2 is described. Measured values for different compositions and temperatures are analyzed. (D.C.C.)

18247 (WHAN-SA-96) MOLYBDENUM DISTRIBUTION IN IRRADIATED OXIDE FUELS. Lawrence, L. A.; Christensen, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab. WADCO Corp., Richland, Wash.). 3 Nov 1970. Contracts AT(45-1)-1830; AT(45-1)-2170. 14p. (CONF-701102-13). Dep. NTIS.

From Meeting of the American Nuclear Society, Washington, D. C.

Electron microprobe analyses of metallic fission product inclusions in mixed-oxide fuels for molybdenum have been performed. A decrease in the molybdenum concentration of metallic fission product inclusions moving toward the fuel center was measured. Because of the relatively short half-life of the only gamma active molybdenum isotope present (^{99}Mo, $\tau_{\frac{1}{2}}$ = 67 hours) gamma-

ray microbeam scanning and similar experimental techniques had not previously been possible. Because of the close proximity of the special irradiation facilities at the Hanford reactors to the BNW Radiometallurgy Laboratory, it was possible to reduce the elapsed time from sample discharge to postirradiation examination to less than one week. This short elapsed time permitted gamma-ray spectrometric techniques to be used for measuring molybdenum activity profiles in several irradiated UO_2–25 wt % PuO_2 fuel pins. 5 references. (auth)

18248 GAMMA-SPECTROMETRIC BURNUP DETERMINATION IN REACTOR FUEL RODS. Hiller, S. (Siemens AG, Erlangen, Ger.). Kerntechnik; 12: 485-90(Nov 1970). (In German and English).

The description of an experimental arrangement for the nondestructive γ-spectrometric determination of burnup in reactor fuel rods is followed by a discussion of the possibilities of use of scintillation counters and of Ge(Li) diodes. The scintillation counter is suitable for measuring the relative burnup profiles of fuel rods, whereas the Ge(Li) diode is used for absolute burnup determinations. After the arrangement was calibrated with fuel rod shaped standard sources, the burnup at one point of one fuel rod was determined redundantly via the Cs 137, Ce 144 and Zr 95 gamma intensities and was compared with values determined radiochemically. The migration of Cs 137 was demonstrated and its effect on the burnup determination was investigated. (auth)

18249 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Williams, Albert Etheridge; Linkison, William Simpson (to United Kingdom Atomic Energy Authority). British Patent 1,219,264. 13 Jan 1971. Filed 12 Apr 1967.

Reference is made to cluster type fuel elements, having spaced parallel fuel pins comprising elongated sheaths containing ceramic fuel. Fuel pins of this type are subject to the disadvantage that, if a temperature excursion of the reactor should occur, there is a possibility that the fuel material in the center region of the pins may melt and cause reorientation of the fuel within the sheath; due to this the characteristics of the reactor core may change and give rise to a power excursion. Differential thermal expansion between fuel material and sheath could also cause a change in the temperature coefficient of reactivity. In the fuel element described the sheath has a number of longitudinally spaced regions of reduced diameter, the fuel material at these regions having a decreased heat rating, with less tendency to melt if a temperature excursion should occur, and providing a barrier against fuel reorientation as well as assisting in preventing large changes in temperature coefficient due to differential thermal expansion. The fuel material, at least in the regions of reduced diameter, should be in vibrocompacted powder form. Alternatively, the bulk of the fuel may be of pellet form, with the vibrocompacted fuel powder at the reduced diameter regions separated from the pellet stacks by thin metal disks. Methods of manufacture are described. (UK)

18250 NUCLEAR REACTOR FUEL ELEMENT HOLD-DOWN AND TIGHTENING MECHANISM. Johnson, Melvin L. (to United States Atomic Energy Commission). U. S. Patent 3,549,491. 22 Dec 1970. Filed 21 Nov 1968.

A positive means is described for preventing the hydraulic forces of liquid coolant from lifting fuel elements from their intended location in the core of a nuclear reactor, and to prevent disturbances of the core neutronics by preventing lateral motion or vibration of the fuel elements. This is accomplished by a bayonet lock which holds down a central fuel element of a cluster of elements, by mechanically activated pads which load the central element outward against the adjacent elements to prevent lateral motion, and by retractable arms which extend over the adjacent elements to prevent their upward movement. (auth)

18251 DEVELOPMENT OF EMERGENCY AND CONTROL DRIVES AND ROD-POSITION INDICATORS FOR NUCLEAR REACTORS IN THE CENTRAL RESEARCH INSTITUTE OF PHYSICS. Muzsnay, L.; Probald, V.; Bollok, L.; Zobor, E. (Central Research Inst. for Physics, Budapest). Kernenergie; 13: 360-6(Nov 1970). (In German).

The design of the servomechanisms and rod-position indicators provided for the drive and control of control and emergency rods of reactors is described. The experience gathered during development and testing is reported. 6 references. (auth)

18252 DATA OF HEAT TRANSFER TO WATER IN ONCE-THROUGH BOILERS AND REACTOR CHANNELS UNDER PRESSURES OF 170 TO 215 BAR. Herkenrath H.; Moerk-Moerkenstein, P. (EURATOM, Ispra, Italy). Atomkernenergie; 16: 207-11(1970). (In German).

The layout of once-through-boilers and reactor channels requires data of the heat transfer to water. In two working-tables experimental heat transfer coefficients to water at forced flow and pressures of 170 to 215 bar are grouped. The heat transfer coefficients and the onset of "heat transfer crisis" for various tube diameters, pressures, mass- and heat flux densities are obtained. 4 references. (auth)

18253 TESTS AND RESEARCHES CONCERNED WITH STRUCTURAL DESIGN CRITERIA FOR PRIMARY COOLANT PIPING SYSTEM OF NUCLEAR REACTOR. 2. STRAIN-CONTROLLED LOW-CYCLE FATIGUE STRENGTH OF SMALL SPECIMENS. Yosetsu Gijutsu; 18: No. 8, 145-52(Aug 1970). (In Japanese).

The experimental results of the thermal fatigue strength and low cycle fatigue strength of steel specimens at high temperature are presented. The specimens were A302B steel and AISI 304L steel. The specimens were made from each base metal and weld metal, and the shape of the fatigue test specimens was a thin-walled cylinder. Thermal cycle was applied by the electrical heating of the specimens and compressed air cooling of the inside the specimens. Strain controlled fatigue test at room and high temperature and thermal fatigue test were carried out. Strain, stress, temperature and number of cycles were measured. The test results are shown in diagrams and discussed. The coefficient of fatigue strength reduction due to the presence of welded joints is 1.5 to 3.0 for 304L steel. The strength of A302B steel welds is higher than the base metal. (Japan)

18254 TESTS AND RESEARCHES CONCERNED WITH STRUCTURAL DESIGN CRITERIA FOR PRIMARY COOLANT PIPING SYSTEM OF NUCLEAR REACTOR. 2. STRAIN-CONTROLLED LOW-CYCLE FATIGUE STRENGTH OF SMALL SPECIMENS. Yosetsu Gijutsu; 18: No. 5, 125-34(May 1970). (In Japanese).

Notch effect for strain-controlled low-cycle fatigue strength of matrix and weld joint materials at room temperature is examined. Hour-glass and circumferentially V-notched (60°) specimens were used. The notch radius of latter type specimens was changed by five stages. For weld joint materials, weld method was changed (hand, submerged, slag welding). Tests were performed within the life of 10^5 cycles by diametral-strain controlling method. Strain ratio was −1. Test data were proposed by many figures and tables. The results are reported. (Japan)

18255 TESTS AND RESEARCHES CONCERNED WITH STRUCTURAL DESIGN CRITERIA FOR PRIMARY COOLANT PIPING SYSTEM OF NUCLEAR REACTOR. 2. STRAIN-CONTROLLED LOW-CYCLE FATIGUE STRENGTH OF SMALL SPECIMENS. Yosetsu Gijutsu; 18: No. 7, 135-46(Jul 1970). (In Japanese).

The influence of strain ratio and notch ductility for low-cycle fatigue of reactor cooling system piping is analyzed. The influence of strain-ratio is described and test results are presented. The strain-controlled low-cycle fatigue characteristics at low temperature where notch-ductility decreases is researched. Results are presented. (Japan)

1825б TEST CONCERNING THE STRUCTURAL DESIGN CRITERIA FOR THE PRIMARY COOLANT PIPING OF A NUCLEAR REACTOR. Yosetsu Gijutsu; 18: No. 4, 148-50(Apr 1970). (In Japanese).

Low cycle fatigue and thermal fatigue fracture among the fracture modes for primary coolant system pipings is measured. Fatigue tests were performed for A302B and AISI 304 steel. (Japan)

18257 APPLICATION OF THE FINITE ELEMENT METHOD TO PRESSURE VESSEL DESIGN. Kawai, Tadahiko (Tokyo Univ.). Koatsuryoku; 8: 1877-85(Jan 1970). (In Japanese).

The utilization of the finite element method for the rationalization of pressure vessel design is mentioned. The theory of shell structure based on Kirchhoff–Love's assumption, and the outline of shell structure analysis by the displacement method are explained, and the advantages and disadvantages of the several finite elements and their displacement functions used for shell structure analysis are mentioned. As an example of the shell structure analysis by the finite element method, the computed results of the following problems are analyzed: stress concentration of a cylindrical shell having circular holes; problem about the bending deformation of a cylindrical shell; and stress distribution of a cylindrical shell having slits. (Japan)

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GENERAL

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18259 (AEC-tr-7094) CHLOROPHYLL METABOLISM IN GREEN PLANTS. Shlyk, A. A. Translation of Metabolizm Khlorofilla v Zelenom Rastenii, Izdatel'stvo Nauki i Tekhnika, Minsk, 1965. 291p. (TT-70-50009; IPST-Cat.-5679). Dep. NTIS.

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Germanic	ä	appears as ae
Germanic	ö	oe
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Cross references are included in cumulative subject indexes and in *Subject Headings Used by the USAEC Division of Technical Information* (USAEC report TID-5001).

The reader is also referred to *Guide to Abstracting and Indexing for Nuclear Science Abstracts* (USAEC report TID-4576).

Most headings in the subject index are specific materials, things, and processes. The headings are followed by modifiers that describe the properties of, or processes applied to, the headings.

All index entries cite *NSA* volume and abstract numbers; volume number precedes the colon and the abstract number follows it. The designation (R) following the abstract number indicates a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Report numbers, where applicable, are included in parentheses after the abstract number of the citation. Published literature (journal article or book) can be identified by the absence of a report number.

Ideas presented in the original literature, rather than key words, have been indexed. The indexers have selected what seemed the most probable and logical place to look for typical information. Since it is not always possible to anticipate where a user would look for information, the cumulative indexes include numerous cross references. Consideration of synonymous or closely related terms will prove valuable.

Information is indexed for the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use or to the general class headings that include the specific headings. For example, information on boiler design for the Fermi Fast Breeder Reactor would be indexed under the headings BOILERS and FERMI FAST BREEDER REACTOR but not necessarily under the headings REACTORS, FAST or REACTORS, BREEDER.

General or broad headings are reserved for general summaries, reviews, comprehensive reports, and similar literature.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings; e.g., AMINO ACIDS rather than ACIDS, AMINO; HELIUM ISOTOPES He-4 rather than HELIUM—ISOTOPES He-4 or HELIUM—He-4 ISOTOPES. Note, however, that in some cases parenthetic modifying terms or inverted headings such as NEUTRONS, FAST, are used where the alphabetical arrangement of a direct entry would cause information to be scattered. In addition, organic compounds are usually entered in the index in the inverted form to facilitate grouping like or related compounds with the parent compounds; e.g., BENZENE, BROMO- rather than BROMOBENZENE. In general, the nomenclature used is that of the subject indexes to *Chemical Abstracts*.

Alphabetization

Subject headings are alphabetized word by word. Parenthetic qualifiers, numbers, and Greek letters within subject headings are disregarded in alphabetizing unless there are two or more headings that are otherwise identical, in which case the qualifier, numerical progression, or spelled names for the Greek letters determine the order.

Examples:

M-Capture
  see ELECTRON CAPTURE
MAGNESIUM
MAGNESIUM ALLOYS AND SYSTEMS
MANGANESE FLUORIDES
MANGANESE FLUORIDES MnF_2
MESONS
MESONS (π)
MESONS (ρ)
1-PENTANOL
2-PENTANOL

Modifying Phrases

The modifiers appearing under a subject heading are written specifically to show the relation between the item being indexed and the heading. The modifier therefore contains a maximum of useful information. Although the modifier begins with the word judged to be of greatest use to the greatest number of users, there is still need for the searcher to consider all modifiers under the heading(s) of interest.

Modifiers usually form meaningful phrases when combined with the subject heading. Some are intended to be read following the subject heading, e.g., the entry HYDROGEN—sorption by charcoal should be read "hydrogen sorption by charcoal." As a result of placing the important word first, however, many modifiers must be rearranged for smooth reading, e.g., FORMALDEHYDE—yields in radiolysis of ethyl ether, effects of deuterium on, should be read "effects of deuterium on formaldehyde yields in radiolysis of ethyl ether" and URANIUM—crystal structure of, effect of cooling rate on allotropic transformations in, should be read "effect of cooling rate on allotropic transformations in crystal structure of uranium."

Special characters are added to modifiers in the fields of physics and reactor technology; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the abstract number.

Physical States and Configurations of Materials

The specific physical state, if other than normal, or the geometric configuration of the material is included in the modifying phrase; e.g., information on liquid metals is indexed under the specific metal with "liquid" in the modifier and carbon crucibles is indexed under CARBON with "crucibles" appropriately placed in the modifier. The information on carbon crucibles is also indexed under CRUCIBLES.

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed to subject headings in the direct form. Cations are listed in the order of increasing valence for polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., SODIUM ALUMINUM SILICATES and POTASSIUM SODIUM SULFATES. If more than one anionic species is presented in a compound, the anions are arranged alphabetically, e.g., BERYLLIUM FLUORIDE HYDROXIDES.

Nomenclature of Organic Compounds

Organic compounds are indexed by subject headings based on the indexes to *Chemical Abstracts* except in the area of enzymes, in which specific enzymes, named according to the 1964 recommendations of the International Union of Biochemistry, are used. In many cases nonproprietary names for drugs are used as subject headings, and cross references are made from the systematic chemical names. Subject headings for hormones appear in the inverted style at HORMONES.

Nomenclature of Life Sciences

Subject headings for plants are names of phyla with one exception: members of the Phylum Tracheophyta are indexed under class or subclass names. Scientific names (genus and species) are used as the initial, or file, word in the modifying phrase. Scientific names are omitted only when the name is not available in the literature or cannot be found in available references.

Subject headings for animals are the names of phyla with the following exceptions: (1) members of Phylum Arthropoda and Phylum Chordata are indexed under appropriate class name, and (2) common names are used for members of Class Mammalia.

Subject headings are entered for various classes of commodities, and specific products are identified in the file-word position of the modifier. In the following examples, approved subject headings are capitalized and typical modifier file words are listed in lower case.

Example 1	Example 2
CEREALS	MEATS
bread	beef
flour	fish
oats	mutton
rice	pork
rye	poultry
wheat	seafood

Diseases, pathological conditions, and in vitro studies of atypical cells and tissues are indexed under subject headings for the organism affected, under the appropriate anatomical structure of physiological phenomenon affected, and under the appropriate disease heading. Subject headings for diseases (defined as any deviation from the norm) are DISEASES; DISEASES, INFECTIOUS; DISEASES, NEOPLASTIC; DISEASES, PHYSIOLOGICAL; DISEASES, PLANT; and DISEASES, TRAUMATIC.

Diseases of mixed etiology are treated in the following manner: neoplastic diseases that are also classified as infectious or physiological are indexed under DISEASES, NEOPLASTIC; diseases in which a microorganism is the etiologic agent are classified under DISEASES, INFECTIOUS; physiological anomalies that are neither neoplastic nor infectious are indexed under DISEASES, PHYSIOLOGICAL; the acute radiation syndrome, nonspecific radiation injuries, trauma, and wounds or incisions inflicted mechanically are indexed under DISEASES, TRAUMATIC.

Specific diseases or pathological conditions are named in the file-word position of the modifier, in the author's terminology, and are set off from the remainder of the modifier by commas. Neoplasms are designated as benign or malignant in the file-word position when more specific information is not available.

Multicomponent Alloys and Other Systems

Multicomponent alloys and systems, except well-known trade names, are indexed under a subject heading for each component in the form "element systems" for nonmetals or "element alloys and systems" for metals. The modifier begins with element symbols for each component arranged alphabetically. In addition, if significance is placed on the base metal of the alloy, this is indicated by adding "-base" to the element symbol.

Example: A 1.5C, 12Cr, 0.25V, 0.8Mo, bal Fe alloy is indexed as

```
CARBON SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
CHROMIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V,...
IRON ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
MOLYBDENUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
VANADIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
```

Well-known alloys, such as ZIRCALOY-2, are indexed under the trade name; cross references from each component of the alloy to the trade name appear in cumulative indexes.

Multicomponent systems in which nonmetallic elements are present in large percentage and which are commonly referred to as systems or mixtures are indexed in a manner similar to alloys.

Example: A tungsten–silicon preparation is indexed as

```
TUNGSTEN ALLOYS AND SYSTEMS
  Si--W, ...
SILICON SYSTEMS
  Si--W, ...
```

Multicompound systems and mixtures of inorganic compounds are indexed under the subject heading for each component compound; the modifiers begin with an alphabetical listing of compound formulas.

Example: A lead titanate–lead zirconate mixture is indexed as

```
LEAD TITANATES
  PbTiO3--PbZrO3
LEAD ZIRCONATES
  PbTiO3--PbZrO3
```

A mixed system of compounds and elements is indexed by a combined form of the preceding conventions; e.g., a dispersion of copper and alumina would be indexed as

ALUMINUM OXIDES
Al_2O_3—Cu, ...
COPPER ALLOYS AND SYSTEMS
Al_2O_3—Cu, ...

Mixtures of organic compounds are indexed under subject headings for each component of the mixture; the modifiers begin with an alphabetical listing of compound names.

Example:

ACETIC ACID
acetic acid—BF_3, ...
BORON FLUORIDES
acetic acid—BF_3, ...

Example:

BENZENE, CHLORO-
bromophenol—chlorobenzene, ...
PHENOL, BROMO-
bromophenol—chlorobenzene, ...

If modifiers for alloys and systems are included with other modifiers under the same subject heading, they are filed last.

Example:

CARBON SYSTEMS
deposition on nuclear fuel particles
molecular structure of
neutron total cross section for
sorptive properties for xenon
Young's modulus for
Al—C—Cr, superconductivity in
B—C, phase studies for
C—U—Zr, fabrication and physical properties of

Nomenclature of High Energy Physics

Information on particle-particle events is indexed under subject headings for the specific particles involved. The modifier file word *interactions* is followed by the specific interaction written in symbolic form. Particle nomenclature and symbols follow that of Rosenfeld, et al. *Data on Particles and Resonant States,* UCRL-8030 (latest revision). For consistency the incident particle is always written first. The mass (in MeV) of a resonance state is included in parentheses after the symbol to avoid ambiguity. Hyperfragments are indicated in modifiers as in the following examples: Λ-He^5, Σ-H^3, $\Lambda\Lambda$-Be^{10}. The superscript on the right indicates the total number of baryons in the composite system.

Examples:

MESONS (π^-)
interactions $\pi^- + p \rightarrow \Lambda + K^+ + \pi^-$ at 6 GeV/c in hydrogen bubble chamber, $\Lambda K(1700)$ enhancement in, (E)
BARYONS, RESONANCE (N^*)
production of $\Delta^{++}(1236)$ and $\Delta^0(1236)$ from $K^- + p \rightarrow K^- + p + \pi^+ + \pi^-$ interactions at 2.63 and 2.70 GeV/c, (E)
HYPERFRAGMENTS
binding energy of $\Lambda\Lambda$-He^6, three-body α—Λ—Λ model for

Subject headings are also provided for specific models and theories.

Examples:

ELEMENTARY PARTICLE MODELS (TRIPLET)
hadron total cross sections in quark, numerical analysis of
CURRENT ALGEBRA
PCAC hypothesis for A_1 and rho dominance in $\pi \rightarrow e + \nu + \gamma$ decay
REGGE POLE THEORY
predictions for polarization in $K^- + p \rightarrow$ anti $K^0 + n$, $\pi^- + p \rightarrow \pi^0 + n$, and $\pi^- + p \rightarrow$ eta + n interactions at high energies
SYMMETRY GROUPS
$SU(2) \times SU(4)$ intermediate-coupling model for nucleon and hyperon isobars

Nomenclature of Reactor Technology

Subject headings for reactors are of three types:

(1) Specific reactors, e.g., ARGONNE RESEARCH REACTOR, SAXTON POWER REACTOR

(2) Reactors having a common physics or engineering characteristic, e.g., REACTORS, FAST; REACTORS, ORGANIC-COOLED; REACTORS, PRESSURIZED-WATER

(3) Reactors having a common purpose, e.g., REACTORS, POWER; REACTORS, RESEARCH

Information on specific reactors, type (1), is indexed under the one specific subject heading. Information on classes or types of reactors, types (2) (characteristics) and (3) (purpose), is indexed under all applicable headings. For example, information on a heavy-water-moderated organic-cooled power reactor is indexed under REACTORS, HEAVY WATER-MODERATED; REACTORS, ORGANIC-COOLED; and REACTORS, POWER.

Subject headings exist for selected reactor components, e.g., REACTOR FUEL ELEMENTS. When applicable, headings for components are indexed even though they may have been included in a modifier under a type (1) or (2) heading. The materials in reactor components are indexed when the information is peculiar to the material.

Modifier file words under reactor headings are of two primary types: one type expresses reactor characteristics, e.g., reactivity; the other, components, e.g., control rod. If no subject heading appears for a reactor component, the heading REACTORS is used, and the component is used as the modifier file word.

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Reports, conference papers and proceedings, numbered translations, and patents are included in this index. Each item is listed by report number; this is followed by the abstract number and a brief notation regarding public availability. The index entries show which reports are on file in the institutions listed on the back of the front cover (Dep.), which reports have been published in open-literature journals (journal citation), and which reports can be purchased (source and price). Whenever a report is identified by more than one number, the availability is given under the primary number, and a cross reference is given under the secondary report number.

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CERN European Organization for Nuclear Research. Available without charge from CERN European Organization for Nuclear Research, Geneva 23, Switzerland. Copies are deposited in libraries throughout the world.

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Service Central de Protection contre les Rayonnements Ionisants. Copies are available from Ministère de la Santé Publique, Service Central de Protection contre les Rayonnements Ionisants, B.P. n° 78 Le Vesinet (France) Telex 25667.

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